July 5, 1944

NATIONAL PETROLEUM NEWS

TECHNOLOGY DEPT.

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DETROIT

Refiners Accept Challenge for 'More and More' Aviation Fuel

Refiners of 100-octane aviation gasoline were told by high ranking Army, Navy and government officials in Washington this week that the armed forces must have "more and more high octane aviation gasoline". Some of the officials who attended the meeting are shown here. They are, left to right, seated, Air Marshal Sir William L. Welsh of the R.A.F.; PAW Chief Ickes; Gen. H. H. Arnold. Standing: H. Wilkison, British petroleum representative; Deputy PAW Davies; Harry G. Burks, jr., chairman of the Aviation Gasoline Advisory Committee of PAW; and Admiral DeWitt Ramsey, Chief of Bureau of Aeronautics, U. S. Navy. Refiners left sobered by the staggering demands but confident they will be met

Also snapped in attendance at the refiners' meeting in Washington called by PAW Ickes was this group, left to right: G. L. Stewart, Imperial Oil Co., Ltd.; F. W. Abrams, Standard Oil of New Jersey; Charles Rayner, State Department petroleum advisor; W. D. Crampton, PAW director of foreign supply and distribution

(Story on refiners meeting with military chiefs, p. 22; Davies reports United Nations' 100-octane construction program 80% complete, see p. 24)

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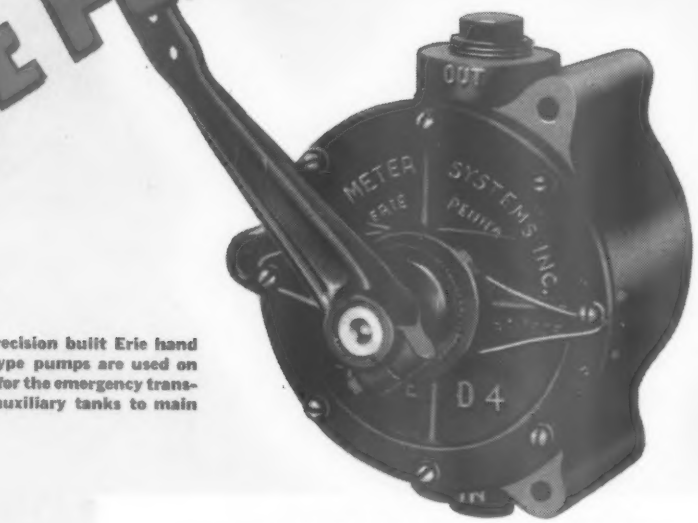
ERIE PUMPS IN THE AIR

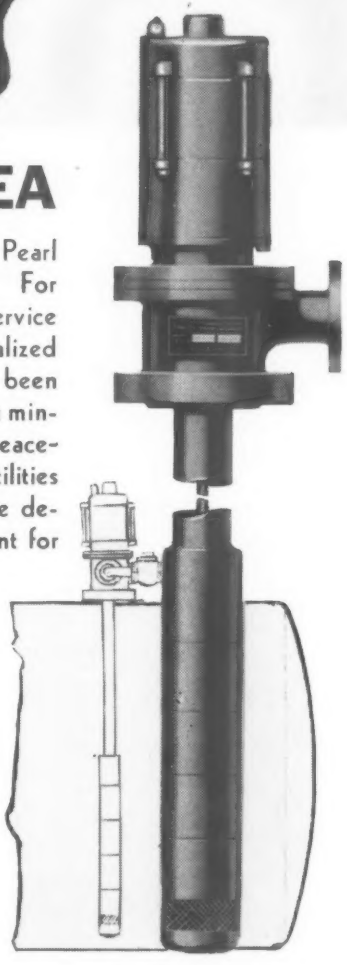


Thousands of these precision built Erie hand operated oscillating type pumps are used on war planes of all types for the emergency transfer of gasoline from auxiliary tanks to main tanks.

On the LAND - *On the* SEA

ERIE'S pump building experience since Pearl Harbor is concentrated on war applications. For the duration, the famous Erie Computor Service Station Pump has given way to these specialized units and other war products. We have been able to fit our plant into war demands with a minimum of change and will swing into the peacetime line of Erie products as soon as the hostilities cease or the go ahead is given. We have developed a complete line of fueling equipment for airports which meets today's war needs and those of the post war period.

An economical hand-operated oscillating type pump for use in dispensing petroleum products from barrels. This unit helps the war effort by providing an expedient means for industrials and farmers to fuel their gasoline powered equipment. Specifications: 6 G.P.M. at 60 full strokes-7 ft. of hose.



Erie Submerged Turbine Pumps are built to handle aviation grade fuel. Used extensively for refueling planes and other gasoline powered vehicles. Built for capacities from 25 to 75 G.P.M. for heads up to 75 ft. and pressures from 10 to 35 P.S.I.

ERIE METER SYSTEMS, INC.

Main Office and Plant: Erie, Pa.

Facts and Flashes

From the
ETHYL CORPORATION
Chrysler Building, N.Y.C.

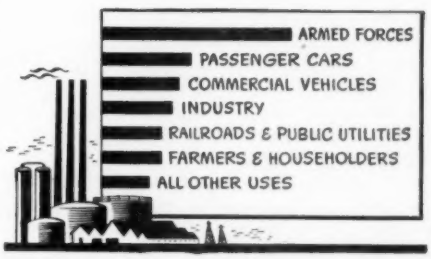
NOT ALL DEALERS IN RURAL AREAS are fully aware of the tremendous market for gasoline and lube products which is growing right under their noses. Reports indicate that there will be a big demand for farm machinery and equipment as soon as production can be expanded. Production of tractors and other machines has been limited for the past three years because of Army and Navy demands.

In answer to a poll, 44% of farmers questioned stated that after the war they planned to buy a new tractor —and 47% replied that they would buy a new automobile. Furthermore, farmers expect and will undoubtedly get better tractors with more power for size of engine—wider range of tools for tractors, easier to attach and detach—and new field machines to save time and labor in hay production and small grain harvesting. Result will be higher percentage of mechanized farms; greatly increased use of gasoline-powered equipment.

U. S. ARMY and DEPARTMENT OF COMMERCE are working on a book designed to help discharged service men get into service station business at the close of the war. Proposed title is: "Establishing and Operating a Service Station."

WILL THERE BE ENOUGH PETROLEUM for synthetic rubber tires after the war? This question is definitely answered by facts and figures. Sixteen gallons of butylene, a widely produced petroleum product, will make four tires for the average passenger car. These tires will run for at least 20,000 miles. Fuel requirements for the same car at 15 miles per gallon would be 1,333—or about 90 times the amount required for tires.

ARMED FORCES are taking about 32% of the petroleum products now being produced in this country. 15% is being used to provide gasoline and lubricants for passenger cars. Commercial vehicles take another 13%, industry gets 12%, railroads and public utilities use 10%, farmers and householders use 10%, with the remaining 8% supplying all other requirements.



Late Flash

Survey just completed of antiknock value of civilian gasolines throughout the United States shows no change whatever in octane rating of premium gasoline and a drop of only one-tenth of an octane in regular as compared with a similar survey made last winter.

George E. Dewey Succeeds F. H. Harbison as PAW Labor Counselor

George E. Dewey

Frederick H. Harbison

GEORGE E. DEWEY this week became top man of PAW's office of labor counselor, one of the oil agency's smoothest, quietest-running, yet efficient units, succeeding Frederick H. Harbison whose know-how in handling oil labor relations and manpower problems has greatly aided in carrying the industry over many high hurdles along the road to all-out war production.

The new labor counselor has been an assistant to Mr. Harbison since April of 1943 and before that, a special assistant to PAW Assistant Deputy Administrator Bruce K. Brown for many months.

Mr. Dewey has the fullest confidence that the industry's manpower problems in the months to come until the war's end will be licked, although they may at times be tough nuts to crack. On this point, he promises no miracles, but rather lays much of the responsibility for future success on manpower problems squarely in the industry's lap.

"I expect," Mr. Dewey told NPN, "to call on industry frequently for advice and for its full co-operation in the establishment of whatever operational manpower techniques may become necessary.

"And, in that connection, I'd like to point out that we have had the fullest possible co-operation from the industry on programs which have been necessary in order to avoid manpower situations which would have resulted in losses of vital war product production."

Here are the four big jobs Mr. Dewey sees ahead on oil manpower, not necessarily in order of importance, and which the industry will hear more about from him personally later on:

1. Establishmest of proper hold-the-line levels of technical, skilled and semi-skilled personnel in all operating branches of the industry.

2. Establishment of suitable aviation gasoline process maintenance and "turn-around" crews, particularly in areas of critical manpower shortage and in the smaller 100-octane plants.

3. Securement of increased personnel in the production branch of the industry to meet increased crude demands.

4. Establishment of proper working arrangements with WMC's area offices in order to insure that recruitment for the essential branches of the industry can go forward without interruption.

Mr. Dewey attended Purdue University from 1924 to 1926, then the Colorado School of Mines from 1927 to 1929, receiving a petroleum engineering degree. In February 1930, he joined Indiana Standard, engaging in chemical research at its Whiting, Ind., refinery. In 1937, he went to the company's Chicago office to head the technical information division in the development and patent department. He is a member of the American Chemical Society and editor of the *"Chemical Bulletin."*

While with PAW, Mr. Harbison was on leave from the University of Chicago where he was teaching in the economics department. His Ph.D. —he is entitled to stick "Dr." before his name, but prefers not to—was obtained in 1940 from Princeton University where he had been awarded an A.B. degree in 1934.

Prior to coming with PAW in March, 1943, Mr. Harbison was a labor consultant to the Office of Production Management's iron and steel branch, then manpower consultant to WPB's automotive branch at Detroit and civilian personnel chief at the War Department.

When Mr. Harbison leaves PAW on July 5, he will return to the University of Chicago, engaging in re-employment and retraining planning. He will also probably serve as a consultant on such matters with governmental agencies in Washington.

He thinks a great deal of PAW and firmly believes that it is one of the best run and administered agencies he has had the opportunity to serve. He is also grateful for the intelligent and forward-looking manner in which the industry has applied itself to its wartime manpower problems, pointing out that much of its ability to meet these tasks lies in its far-flung committee, and subcommittee, setup.

Associated with Mr. Dewey in the labor counselor's office will be Samuel E. Hill, who came to PAW in May, 1943, and Karl Worth, who prior to his coming to PAW in September, 1943, was with WMC as an occupational analyst for the agency's essential activities and occupations committee.

New Wartime Edition

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NATIONAL PETROLEUM NEWS—July 5, 1944—Vol. XXXVI—No. 27. Published every week at 1213 West 3rd St., Cleveland 13, Ohio, U. S. A. Subscription rate $5.00 per year in United States, Mexico, and Pan-American countries; $6.50 Canada and foreign countries. Entered as second class matter Jan. 17, 1910 at Cleveland, O., post office under act of March 3, 1879, by The National Petroleum Publishing Co.

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NATIONAL PETROLEUM NEWS
NPN
NEWSMAGAZINE FOR OIL MANAGEMENT MEN

Lower Housebrand Rating to Bring Price Cut

PAW Holds Off Order Reducing Octane Rating to Permit OPA Draft Price Change; Reduction May Not Extend to Dealer Level

NPN News Bureau

WASHINGTON—PAW's plan to cut octane rating of housebrand gasoline from 72 to 70 will be followed by a reduction in ceiling prices on the product by OPA, NPN was informed this week.

PAW originally had planned to announce its action July 5 but held off pending determination by the price agency as to what it will do regarding housebrand price if octane rating is reduced.

Subsequently, OPA and PAW officials held a meeting on the subject and apparently came to an agreement regarding the timing of announcement by PAW which will give OPA an opportunity to promulgate an amendment to the price regulations which will reduce ceiling prices on regular grade.

OPA has not yet worked out details of its proposed action, it is understood, and has not decided whether to carry the cut through the entire price structure.

Present indications are that OPA will reduce refiner and jobber prices and probably leave the dealer price where it now stands.

Stripper Subsidy's Debut Is Near, Oil Men Think; Sincere Trial Urged, but Some Bugs Are Sighted

NPN News Bureau

WASHINGTON—The stripper well subsidy plan, developed by OPA, passed to Economic Stabilizer Vinson and then shifted to Jesse Jones for the latter's approval of government funds involved, was still in a state of "suspended animation" this week at NPN press time.

However, it was expected that approval of the program would be officially announced by Mr. Vinson late this week, along with a short general outline of the plan, and that OPA would also issue a coincident announcement the same day stating what part OPA will play in the program's operation. Following these two announcements, Defense Supplies Corp., which probably will handle the actual mechanics of the plan, is expected to issue a regulation spelling out legally all of the mechanical details of the program.

Urges a Sincere Trial

One tip-off that some announcement was near, was this remark by General Counsel Russel Brown of I.P.A.A. in his weekly report to the association's president, Ralph Zook:

"The proposal has now reached the stage where some announcement is expected hourly. It was announced as a definite thing in April of this year."

At the same time, Mr. Brown took occasion to point out once again the industry's strong preference for a general crude price increase but went on to say that if the government should put a stripper well subsidy program into effect, the best thing for the country's producers to do would be to help make the program a success.

This conclusion was expressed in the following paragraphs of Mr. Brown's report:

"The oil industry through its various means of expression—through small associations and large ones—has on many occasions stated its preference for the simple, direct and self-executing price increase method of meeting the several phases of the problem, from wildcatting, through development of fields, secondary recovery, to the final stage of preservation of stripper well reserves. The administration has selected the stripper well phase for treatment.

"The choice was not ours but theirs. However, it is a choice that has been made, and therefore it is necessary for all of us to assist in whatever way we can to make the program do its maximum good. Under a controlled economy we must use whatever tools are available to achieve the broader purpose. There will be certain vexing questions that will arise when the program becomes effective, and I suggest that we give such assistance as we can in their settlement."

It is freely admitted by all concerned with the program that there will be troublesome questions, but proponents of the idea are confident that they can be overcome without too much difficulty.

Easy for Large Refiners

One particularly weak spot according to industry circles, affects the small refiner. They say that many will be hard pressed to pay for their crude because government payments, instead of going to the crude producer, will be paid at the "first purchaser" level. This, they add, will mean that the small refiner, operating on a slim amount of cash in the bank, will be squeezed seriously between the time he buys the crude and the time he receives a check from the government covering the extra cost of the crude.

On top of that, it is pointed out, would be this difficulty: The larger refineries, which are in a strong financial position,

(*Continued on p.* 11)

Bail-out Discussed at OPA-Industry Meeting

NPN News Bureau

WASHINGTON—Pressing problem of a "bail-out" for dealers squeezed unfairly by OPA's service station debiting program will be the main topic of discussion at an OPA-industry meeting here July 6, at which time a concrete program is expected to be worked out.

Other topics on OPA's agenda for the meeting include:

1. Permitting dealers to register less than the physical storage capacity of their stations where their capacity is an excessive amount which is never entirely used.

2. Installing a system of separate accountability for each retail outlet. At present licensed distributors are not held accountable for each of their retail outlets.

3. Naphtha rationing. (In its agenda OPA says that in certain sections of the country, ration free naphtha "is being sold in large quantities which finds its way into automotive uses. This abuse will have to be brought under control.")

4. Present plans for putting dealers on ration banking.

5. Experience to date with amendment 111 to RO 5C—the ban on exchange of non-highway "R" coupons at retail outlets, except under certain limited conditions.

6. Rations for pleasure boats. (On this point the OPA agenda states that "considerable criticism has been received because we issue a greater ration for pleasure boats than we do to the 'A' driver.")

7. Makeup of the industry advisory committee for future meetings.

Eighty Wells Are Completed by Texas Drillers During Week

Special to NPN

AUSTIN—Texas drillers completed eighty oil wells in the week ending July 1, six of which were wildcats, according to the Texas Railroad Commission. This raises the year's total of completed wells to 1714, compared to 986 completed at this same time last year.

The Commission reported that the average daily allowable during the week was 2,216,430 barrels, an increase of 12,256 over the preceding week. The number of producing wells, however—101,079—was 137 fewer than for the prior week, indicating an increasing number of abandonments.

Left: Engineering committee of the Interstate Oil Compact Commission in session during the recent quarterly meeting in Denver. Left to right are: J. F. Gallie, Arkansas; Dean W. H. Carson, Norman, Okla.; Dr. E. De Golyer, chairman, Dallas; John Kelly, New Mexico; Dr. Eugene A. Stephenson, Lawrence, Kans.; Dr. F. M. Van Tuyl, Golden, Colo.

Right: Also attending the compact meeting were, left to right: Former Lieut. Gov. Hiram M. Dow of New Mexico; Senator Carl A. Hatch, chairman of the public lands committee, U. S. Senate; Rep. A. M. Fernandez, New Mexico, member of the House public lands committee

Oil Compact Conferees Urge Frank Co-operation Of U. S. and States; Rap New Leasing Policy

Special to NPN

DENVER—More conferences where members of Congress, federal officials and governors sit down to talk over mutual problems with the petroleum industry would lead to a better understanding and solution of many of the industry's problems, was the general opinion at the Interstate Oil Compact Commission quarterly meeting last week in Denver.

Charges and countercharges which have marked meetings in the past were notably absent.

Keynote of the session was struck by Sen. Carl Hatch of New Mexico, chairman of the public lands committee, who said: "It appears that the oil leasing act should be amended to do away with the necessity for regulations which so often lead to confusion. This is a job for Congress, working with state officials and the petroleum industry.

"No Serious Break"

"To secure the maximum development of the public domain there must be no conflict between federal and state governments. Conflict brings about confusion. We must all co-operate."

Two members of the House Public Lands Committee, Reps. Chenoweth of Colorado and Fernandez of New Mexico, concurred.

Gov. Andrew Schoeppel, of Kansas, chairman of the commission, promised co-operation with federal agencies, as did Gov. Robert Kerr of Oklahoma.

"I feel there is no break between federal and state agencies which cannot be healed," Gov. Schoeppel said. "Governors' conferences the past two years have done much to bring problems to Washington's attention."

The half million acres deeded by the federal government to Wyoming at time of statehood have been of untold value to the state, Gov. Lester Hunt told the conference.

Gov. Kerr of Oklahoma flew to Denver from Minnesota where he had been in seclusion drafting the keynote speech which he will deliver at the Democratic national convention. He intimated that he might have considerable to say in Chicago about closer state and federal co-operation.

Members of the compact, 13 states which produce 80 per cent of the nation's oil, want public lands opened to development, Warwick M. Downing of Denver insisted.

"Practically all the oil fields were discovered by wildcatters, who, at great risks have been almost stopped by royalty scales fixed in Washington," Mr. Downing said.

"If the Department of the Interior pursued a more liberal policy there wouldn't be this gas famine. There is plenty of oil to be found in the Rocky Mountain public land states, but, as always, it is the inevitable tendency of the little fellows in Washington that have been given great powers to deter programs."

New Mexico, represented by Hiram M. Dow, wants the oil leasing act rewritten along more liberal lines. Rep. Fernandez announced that a sub-committee composed of himself, Rep. Chenoweth and Rep. J. Hardin Peterson of Florida would investigate conditions in New Mexico before Congress reconvenes.

Although the crude price structure was not generally discussed at the meeting, Sen. Hatch said the best way to insure increased production would be a price increase.

"There has been no increase in crude prices since October, 1941," he said.

An explanation of the relaxing of PAW control over drilling and equipment use (PAO 11, as amended, and PAO 12) was given by Ralph J. Schilthius of Washington, PAW acting director of production.

"There is a generally improved situation in regard to equipment," he said. "Effective July 1 restrictions on installation of pumping facilities have been removed. Gas wells, except in certain areas, may be drilled without acreage restrictions."

The conference adopted the following report on public land policy:

"We note with dismay that certain branches of the government are going into the oil royalty business: that is, when they sell any government lands, they reserve mineral rights.

"The Bankhead-Jones Farm Act requires that the sale or other disposition of any property acquired by the Secretary of Agriculture shall be subject to a reservation of not less than an undivided three-quarters of the interest of the United States in all coal, oil, gas and other minerals.

"When we consider the enormous

amount of private lands owned and being acquired by the government, much of it subject, or to become subject, to sale, we should resolutely oppose any such practice."

A table, accompanying the report, set forth federal land holdings as 455,633,745 acres of the total land area of the U. S.—1,905,361,920 acres.

"Our government owns nearly 24 per cent of the land in the nation and is constantly buying more. Under the Bankhead-Jones act 5000 farms in Texas and Oklahoma have been purchased and 528,000 acres in Wyoming," the resolution said.

"The secretary of agriculture's regulations concerning disposal of oil and gas rights under the act are even worse than those of the Interior Department. Leases will be issued only when additional oil and gas reserves are needed to meet war needs, or where necessary to prevent drainage. Regulations require a bonus, a rental of 25c the first year, 50c the second year, 75c the third and $1 for the fourth and subsequent years, and the same sliding scale of royalties adopted by the Interior Department, ranging from 12½ to 32%. A $1000 bond is required in all leases, in addition to the drilling bond.

"Thus we have the beginning of a new public lands policy extending to every state, administered by a bureaucracy in Washington. It will vest in federal agents in Washington, often without capability or experience, the power to prevent in large part the development of the mineral resources of the states.

"Under the Mineral Leasing Act, the states in which the public lands are situated get 90% of the revenue, either directly or through the reclamation fund, and the government gets only 10%. Notwithstanding this, federal agents pay little attention to the wishes of those locally concerned, whose wishes should be paramount.

"We strongly oppose the policy set up by the Bankhead-Jones Farm Tenant Act, and all other legislation or policies whereby the federal government seeks to go into the oil royalty business or otherwise seeks to become a proprietor of mineral lands."

N.C.I.P.A. Asks Checkbook Plan for Farm Sales; Demands Observers on Dist. 1 Committees

Special to NPN

CINCINNATI — Cancellation of amendment 111 to OPA ration order 5-C, relating to "R" coupons and substitution of a check book system was recommended to OPA in a resolution passed at a two-day meeting of the National Council of Independent Petroleum Assns. held at Hotel Netherland-Plaza here June 27-28. Another resolution calls upon Deputy PAW Davies to appoint membership representation as observers on Dist. 1 distribution and marketing and supply and distribution committees similar to jobber observers on the same committee in Dists. 2 and 3.

It was stated Dist. 1 had refused N. C. I. P. A. observer membership "because the meeting room wasn't big enough", and N. C. I. P. A. charges direct discrimination against its eastern members.

The Arkansas association reported to N. C. I. P. A. that major companies operating in that state are cancelling F. O. B. jobber contracts and are rewriting them on a delivered basis, with the effect of reducing jobber margins by approximately 0.5c per gal. The matter is being handled with Washington for correction under MPR 88.

Send Telegram to Bowles

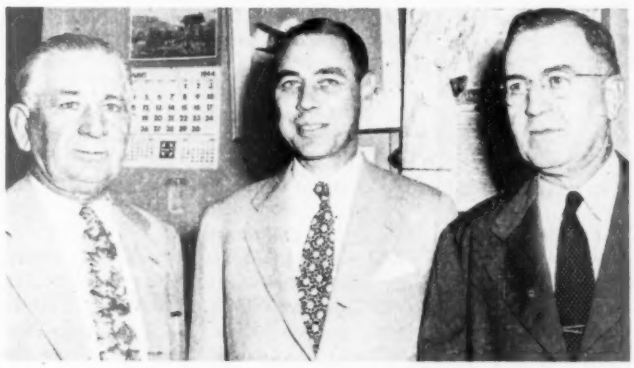
Consensus of the Council regarding reduction of the supply of Ethyl was that distribution should be equitable regardless of stocks on hand or else thrown out entirely, it being considered better to lose that additional profit than to lose contact with customers which could never be regained. However, the council took no definite action, pending further developments, but will push the effort to obtain a jobber margin adjustment to offset the loss and as compensation for handling ration coupons.

Worried over the fate of hundreds of independent dealers and jobbers if OPA enforcement continues suspensions, the following wire was sent to OPA Administrator Bowles asking for bail-out of other than wilful ration violators who have been debited for shortage or acceptance of improper coupons:

"Members of the National Council Independent Petroleum Assn. in regular session Cincinnati today. Reviewed complaints from all parts of nation regarding operations and attitude of OPA enforcement department. Council extremely concerned over fate of hundreds of independent dealers and jobbers if enforcement division continues policy of suspending operations of small oil dealers. Council has urged industry co-operation with OPA in stamping out black market activities. If this industry and OPA partnership is to succeed a more considerate judgment on the part of OPA officials is necessary. Earnestly recommend that unless gasoline dealer has knowingly and wilfully participated in scheme to violate gasoline coupon rationing regulation, dealer deficit be abolished and given opportunity to remain in business. In this connection, council insists problem to be of sufficient importance that you call conference of representatives for the purpose of working out together an equitable policy for the future. Unless this be done war effort will be seriously affected. Also urge you to discontinue suspension orders until such time as policy can be agreed upon. Our plea is not in behalf of those deliberately engaged in schemes to violate regulations."

Council members at their meeting also discussed the advisability of trying to combine into one organization, the Council representing the marketers and independent producers and refiners "to see if by uniting our voices we could not better accomplish more for the independent segment of the petroleum industry." Chairman Phil Williams was instructed to explore this possibility.

N. C. I. P. A. plans to maintain a data file on oil jobber publications and serve as a clearing house on advertising rates. Further Council meetings for the summer have been called off unless circumstances require the calling of a special meeting.



Above, at left, is Charles L. Orr, sparkplug of the Interstate Oil Compact Commission for the last five years, who attended his last session as executive secretary of the compact in Denver last week. He resigned to take over a promotion job with the Natural Gas Assn. With Mr. Orr, center, is

Louis F. Gillespie, newly appointed Illinois ocmmissioner and Samuel F. Peterson, Illinois technical advisor. In the photo at right, left to right, are G. L. Cross, president of the University of Oklahoma; T. A. Morgan, Kansas commissioner and J. C. Hunter, Texas commissioner

Industry Leaders Study Republican Oil Plank; 'Satisfactory', Says Moore, Who Helped Frame It

NPN News Bureau

CHICAGO—As the 1944 Republican Convention passed into history here, oil men throughout the nation began to make a close study, not only of the records of the Presidential and Vice Presidential candidates, but of the platform to which they are committed.

Leaders in the petroleum industry gave particular scrutiny to the "oil splinter" in the "Problems of the West" plan, which was a brief summary of party workers' discussion of oil. Inserted into the plank by Sen. Edward H. Moore, of Oklahoma, it consists of the following short phrases:

"(i) Continuance, for tax purposes, of adequate depletion allowances on oil, gas and minerals; (j) administration of laws relating to oil and gas on the public domain to encourage exploratory operations to meet the public need."

Domestic Policy Studied

Explaining to NPN the reference to oil and related problems, Sen. Moore said:

"The depletion allowance has been so thoroughly established it is now considered a common right that it should be maintained. We considered adding a plank or statement on the bad effects of OPA price controls, but couldn't get it all in and it was decided to leave it out. The whole platform, I think, is generally satisfactory as written."

The oil industry was also particularly interested in the party domestic policy which stresses liberty at home; business and industry restoration to peace time basis as quickly as possible with prompt settlement of war contracts and the protection of small business (which was declared the basis of American enterprise); postwar reduction of taxes on individual incomes and corporations; restoration to Congress of currency control; fair protective tariff on competitive products, and relief from New Deal bureaucracy.

Dewey Misquoted

The platform, which will become the basis for the campaign of Gov. Thomas E. Dewey, of New York, Republican candidate for President and Gov. John W. Bricker, of Ohio, Vice Presidential candidate describes this New Deal bureaucracy as "sprawling, overlapping".

"It is undermined," the platform continues, "by executive abuse of power, confused lines of authority, duplication of effort, inadequate fiscal controls, loose personal practices and an attitude of arrogance previously unknown in our history."

Following his acceptance speech, a question put to Mr. Dewey by NPN at a press conference became the basis for an editorial which misquoted the new Presidential candidate. The editorial appeared in Marshall Field's *Chicago Sun* and it attempted to tell Mr. Dewey what he should have answered to NPN's question:

"Are you satisfied with the present gasoline rationing program?"

"Do you know anybody who is satisfied?" Mr. Dewey countered.

The *Sun*, however, in discussing his answer, omitted the word "program", implying that the New York governor frowned upon gasoline rationing as a whole. A portion of the *Sun* editorial follows:

"Mr. Dewey was asked, in his first press conference after nomination, whether he was 'satisfied' with gasoline rationing. He did not reply, 'Look, we've said that the war is out of politics, and I won't make campaign issues out of necessary wartime controls.' He did not say, 'Well, a lot of American boys need gasoline to fight the war, and I won't encourage anybody to think that this home-front sacrifice is unnecessary'.

"These are the things he should have said," continued the Sun editorial. "Instead he blandly replied: 'Do you know of anybody who is satisfied?' Some of Mr. Dewey's partisan supporters will undoubtedly urge him to continue such tactics. One test of his character and statesmanship will be the determination with which he takes his stand on higher ground."

The question put to Mr. Dewey by NPN did not involve the necessity for rationing, but the manner of handling the program, and his reply implied he considered it New Deal bureaucracy.

New Officers of Kentucky Oil and Gas Assn.

M. A. Arvin, Owensboro, was elected president of the Kentucky Oil and Gas Assn. at the annual convention June 23-24 in Lexington. He succeeds N. W. Shiarella, also of Owensboro. Pictured above, left to right, seated, are E. L. McDonald, Lexington, secretary; P. C. Van Gilst, Ashland, vice-president, Mr. Shiarella and Mr. Arvin. Standing, left to right, are M. G. Powers, Huntington, W. Va., vice president; K. Z. Wilking, Owensboro, vice-president; and J. C. Preston, Owensboro, executive secretary-treasurer. Mr. Shiarella was named to the executive board. **(See story, p. 20)**

Gulf Coast 'Gas' Stocks Down But Throughput Increases

Special to NPN

HOUSTON—Stocks of gasoline held by the Gulf Coast Refiners Assn. continue to decrease although the throughput to stills maintains a steady upward trend.

Report of the association for the first half of June shows stocks of gasoline at 1,191,518 barrels, an all-time low in the association's five-year history. The June 15 figure represented a drop of 12,085 bbls. from June 1, and a decline of 1,106,566 bbls. from the stocks on similar date in 1943.

Stocks of automotive gasoline totaled only 416,436 bbls. a drop of 12,872 bbls. from June 1 and represent about 40 per cent of the automotive stocks on same date last year. About one-fifth of automotive stocks is of special military grade and not available for civilian use.

Crude throughput to stills in first half of month was 119,539 b/d an increase of 40,394 bbls. as compared with same period of 1943.

Kerosine stocks of 192,259 bbls. on June 15 were 80,782 bbls. more than June 1. Diesel was oil stocks of 38,467 bbls. reflect a 19,419 bbls. decrease. Stocks of several other grades of gas oil increased 239,234 bbls. to 929,384 bbls. on June 15.

Total stocks held by the association were 3,159,137 bbls. on June 15 an increase of 325,465 bbls. for first half of month, but considerably below 3,953,516 bbls, in stocks on same date last year.

Reaction to Restoring Gasoline Charge Cards Dubious in Credit Men's Omaha Survey

NPN News Bureau

CHICAGO—The Petroleum Division of the National Assn. of Credit Men will hold its annual meeting at Hotel LaSalle here Oct. 23 to 25, D. A. Grant, chairman of the board of governors and Chicago division credit manager for Socony-Vacuum, announced this week in a letter to members.

With the announcement went copies of minutes of a meeting in Omaha, May 16 to 18, containing results of a survey on the use of service station credit cards and dealer opinions as to the desirability of returning to their use. The survey was prepared and discussed at the meeting by Harry E. Butcher, general credit manager of Cities Service. It is divided into two parts, one part covering the cost to the oil company of handling the cards and the other a dealer survey.

"Results from the first part of the survey were rather disappointing," Mr. Butcher said, "many companies reporting that figures were not available."

Cost figures on a per dollar and per gallon basis show:

	—Cost per Dollar—		– Cost per Gallon –	
	Oct. 1942	Oct. 1943	Oct. 1942	Oct. 1943
High	.04564	.04500	.00930	.00922
Median	.03406	.02225	.00681	.00450
Low	.02200	.00100	.00460	.00020
	—Cost per Dollar—		– Cost per Gallon –	
	1941	1943	1941	1943
High	.100000	.15000	.02031	.03040
Median	.03949	.03606	.00816	.00720
Low	.02170	.00150	.00430	.00030

Recalling wartime manpower difficulties, Mr. Butcher said that there was a possibility of considerable error in these preliminary survey figures due to changes in oil company personnel, the new men not being too familiar with the actual situation for the period under consideration.

"The dealer survey," he said, "was more satisfactory, except that all companies had not yet submitted lists of dealers to whom the survey cards had been sent." At time of closing this report, 197 questionnaire replies had been received, which are summarized as follows:

1. In your opinion has the average car owner been inconvenienced by not having a credit card and having to pay cash?
   Yes—14% No—84% Some—2%
2. Do you believe that car owners should have credit cards?
   (a) Local Use—24%
   (b) Vacation Travel—51%
3. Can you serve your customers better when he—
   (a) Pays cash—70%
   (b) Presents a credit card—13%
   (c) No difference—9%
   (d) No answer—8%
4. Would you be in favor of:
   (a) Return of credit cards on a liberal basis—18%
   (b) Return on a restricted basis—36%
   (c) No credit on petroleum products at service stations—44%
   (d) No answer—2%
5. Did the use of credit cards make it necessary for you to carry more credit yourself?
   Yes—51% No—49 %
6. Did you suffer credit losses:
   Yes—57% No—43%
   Estimated per cent:

30%—1	5%—6	1%—10
20%—4	3½%—1	½%—6
15%—2	3%—11	¼%—3
10%—9	2%—17	Less than ¼%—15
6%—1	1½%—3	

The survey, both as to cost and to dealers, is to be continued and a final report made at the October meeting of the association.

Co-op and Agency Tangle With OPA on Dividends

NPN News Bureau

CHICAGO—L. D. Schreiber & Co., and the Marketing Association of America, a co-operative, filed a joint suit in federal District Court here June 28, asking for an order restraining OPA from starting proceedings for the purpose of preventing the co-operative from paying patronage dividends to its members which OPA countered with an injunction suit filed in United States District court at St. Paul, Minn., June 30.

The co-operative charges that OPA has threatened an injunction suit to stop dividends on the grounds that the Schreiber company, exclusive sales agent for the co-operative, owns and controls the co-operative, thereby violating OPA regulations. The Marketing Assn. of America, a Wisconsin dairy co-op representing 70 creameries and cheese factories and serving more than 35,000 dairy farmers in seven states, and L. D. Schreiber & Co., both demand an examination of the facts and company records and a declaratory judgment that the Schreiber company does not control the co-operative. The Schreiber Co. also questions the legality of OPA's filing of the suit in St. Paul since all Schreiber Co. and Marketing Assn. of America witnesses are located in the Chicago and Wisconsin area and, since neither the co-op nor the Schreiber Co. has offices in St. Paul, they contend it will mean greatly increased expense in fighting the suit.

OPA's suit seeks to enjoin the defendants from paying prices for butter in excess of the prices permitted by OPA regulations and from selling butter at overceiling prices.

* * *

Protests Inequity of Tax-Free Status for Co-operatives

NPN News Bureau

CHICAGO—Terming it the greatest economic danger threatening the country at this time, Ben C. McCabe, president, National Tax Equality Association, urged investigation of the provision of Federal taxation which gives co-operatives a tax-free status. His protest was expressed in a telegram sent Henry Morgenthau, Jr., secretary of Treasury and congressional leaders, last week. The danger, he set forth as the opportunity for co-operatives, free from federal taxes, to absorb private business competitors and, thus, eventually convert the nation's business structure from a taxed to a tax-exempt status, insofar as federal taxation of business profits is concerned. (*See NPN, June 28, p. 42*).

As an example, he cited the recent hearing before the Securities & Exchange Commission at Philadelphia of three Ohio co-operatives seeking to purchase a light and power company and railroad property with headquarters at Canal Winchester, O., at higher prices than had been offered by private interests.

"Because the co-operatives are free from federal income taxation, they are able to pay premium prices for business property, as in the Ohio case," Mr. McCabe's telegram said. "When co-operatives acquire such property, the federal government loses needed tax revenue, despite the fact that the character of the business remains unchanged." He added

Ben C. McCabe . . . . Demands an inquiry

that privately owned electric utilities in 1943 paid out 14% of their gross revenues in federal income and excess profits taxes alone, so the value of exemption from such taxes for co-operatives and the potentialities of this escape route from federal income taxes are obvious.

There can be no logical justification for exemption of a business from federal income and excess profits taxation simply because the identity of the owner has changed, he asserted, since, with cost of the war soaring to unprecedented heights, not only in dollars but also in blood and lives of our fighting men, it is imperative that the Treasury Department co-operate with Congress to eliminate the probable billions in losses of national tax income.

Southwest Gets Freer Well Spacing and Home Rule; PAO 11 Is Relaxed for Whole Country, Too

NPN News Bureau

WASHINGTON — PAW this week substantially met the requests of Southwestern producers for relaxation in federal well-spacing regulations and a return to "home" rule, at the same time ordering major relaxations in PAO 11 throughout the rest of the country.

The relaxations ordered in Arkansas, Louisiana, Mississippi, New Mexico, and Texas were announced by PAW on July 1 with issuance of Supplementary Order 12 to PAO 11, also effective July 1.

The new supplementary order contained these main provisions:

1. Restrictions as to the reworking, deepening, or recompletion of wells into another pool have been eased so that wells may be reworked under the same regulations that govern drilling of new wells, as defined in Supplementary Order 12.

2. In the East Texas Field, in Upshur, Gregg, Smith, Rusk, and Cherokee Counties, pumping equipment may be installed on one well to every 10 producible acres, or on any well located on a lease where the Texas Railroad Commission permits the transfer of allowable oil production from one well to any other well located on the same lease.

3. In the remainder of Texas and in Arkansas, Louisiana, Mississippi, and New Mexico, restrictions on the installation or reinstallation of pumping or other artificial equipment have been removed by amending PAO 11.

Davies Explains Change

In commenting upon the new order, Deputy PAW Davies said:

"This action is in line with PAW policy of relaxing restrictions as soon as the general situation permits. Specifically, the order removes the Federal restrictions as to distance between wells and distance between wells and property lines. However, operators must still conform with state regulations."

The relaxations on restrictions ordered for the entire country, aside from those contained in Supplementary Order 12 outlined above, were embodied in an amended form of PAO 11, also effective July 1. However the amendment does not affect the various supplementary orders of the regulation.

Salient changes in the new order, were these:

1. Restrictions on the drilling of dry gas wells, which have been in effect since March 30, 1943, have been modified. Now a gas well may be drilled anywhere in the U. S., if the well is the only drilling or producible well located on a unit consisting of 640 contiguous surface acres. (PAW explained that this provision does not apply to areas that have been designed as "restricted areas".)

The well must be located at least 1320 ft. from every lease, property, and subdivision line separating unconsolidated property interests, and must be at least 3960 ft. from every other drilling or producible well. Previously, the only gas wells that could be drilled without exception to PAO 11 were those allowed by Supplementary Order 1 to PAO 11, which covers the Appalachian region, northeastern Oklahoma, eastern Kansas, and Missouri.

2. Automatic authorization is now granted for the use of materials for gas gathering lines and gas lift and booster plants when the cost of materials for any one complete operation does not exceed $10,000. Previously, it was necessary to file an application for an exception on all projects when the cost of the complete operation exceeded $5000.

3. Automatic authorization is granted for the use of materials for natural gasoline recovery, gas treating, cycling, and pressure maintenance when the cost of material for the one operation does not exceed $10,000. Previously, projects in excess of $5000 required the filing of a request for an exception.

4. Previously, several clauses in PAO 11 made it possible for a natural gas or natural gasoline operator to use up to $500 worth of material for any purpose, even if the material originally had been obtained for maintenance and repair purposes. These clauses have been removed because these provisions are now included under order P-98-b.

(Under a recent amendment to P-98-b, any operator may automatically obtain an AA-1 priority rating for materials costing up to $500. This material may be used for any purpose authorized by PAO 11 or supplementary orders issued under it.)

5. Restriction on the installation or reinstallation of pumping or other artificial lifting equipment have been removed, except as specifically restricted by supplementary orders to PAO 11.

6. Restrictions have been removed to permit the reworking, redrilling, or deepening of any gas or oil well and recompletion of the well within the pool from which it last produced.

PAW's modifying of PAO 11 does not abolish the supplementary orders that have been issued under it, Mr. Davies warned.

Tighter Rationing in Works For Civilian Plane 'Gas'

WASHINGTON—A gasoline rationing program for private airplanes much tighter than the present one is awaiting only the approval of the Army and Navy before being put into effect by OPA, it was learned this week.

The amount consumed daily by private planes throughout the country averages only 6000 bbl., and it is a question of "principle" rather than saving a great amount of gasoline, officials say. They point out that under the present system, whereby owner of a private plane asks for as many ration coupons as he wants from the local board and gets them, there is no answer possible to complaints of passenger car drivers who are severely limited in their use of motor fuel.

The private plane gasoline rationing program has been worked out by OPA in conjunction with Civil Aeronautic Administration. Tentatively, it would provide for private plane pilots only enough gasoline to keep their airplanes in condition while at the same time enabling the pilot to get enough flying hours to retain his CAA license.

Neukom Heads Fuel Rationing; Al Whitman To Be Consultant

NPN News Bureau

WASHINGTON — John G. Neukom this week became director of OPA's fuel rationing division succeeding Al Whitman who has resigned from the post because of illness. Mr. Whitman, however, has been appointed a consultant attached to the staff of the Deputy Administrator, Charles F. Phillips.

Mr. Neukom, who has been assistant director of the division and chief of the fuel oil rationing branch, has been with OPA for over two years. He actively participated in the planning and operation of two of the rationing agency's biggest jobs—rationing of fuel oil and gasoline. He came to OPA from the management engineering firm of McKinsey, Kearney and Co., of Chicago.

Lawrence C. Turner Appointed Inland Waterways Director

NPN News Bureau

WASHINGTON—ODT Director Johnson this week announced appointment of Lawrence C. Turner as acting director of the Inland Waterways Division of ODT, effective July 6, succeeding Glenn E. Taylor, former official of the Federal Barge Lines, who returns to that company as assistant to the president.

'B' and 'C' Drivers Get Tire Quota Boost; 'A' Holders Must Wait

NPN News Bureau

WASHINGTON — July and August civilian passenger car tire quotas announced this week by OPA showed a substantial boost over previous months but were still far from the number needed to meet motorists' demands.

Although OPA had a slight bit of good news for "B" and "C" drivers, motorists in the "A" card class were advised they will probably get no new tires until early next year.

The Office of the Rubber Director has set aside 1,950,000 new passenger tires (grade 1) for July, 50,000 more than the 1,900,000 allocated for June (an original allocation of 1,600,000 plus another 300,000 allocated later in the month.) The July tire allocations from ORD were:

New passenger and motorcycle tires —1,950,000, up 50,000 from June; new truck tires of size 7.50 or smaller, 375,000, up 15,000 from June; new truck tires of size 8.25 or larger, 135,000, up 10,000 from June; tractor-implement tires of size 7.50 or smaller, 55,000, no change; and tractor-implement tires of size larger than 7.50, 23,000, up 3000 from June.

OPA Rationing Deputy Phillips strongly emphasized that request for tires still far exceeds the number available for rationing and that it will not be possible for some time to bring tire supplies in line with demand. The job can be done in the next several months, he added, only if motorists continue to have their tires recapped, as needed, with the high-grade camelback now available.

More Relief in August

"The extra 300,000 tires we received in June and the higher quota we have been given for July will permit us to make a start toward meeting needs of occupational drivers. With the prospect of a quota in August equal to that for July, we may expect further relief," Mr. Phillips said.

"But there is no ground, whatever," he added, "for all occupational drivers who apply to their local rationing boards for new tires to expect to receive them, even though there is no question of their eligibility. The tire problem right now is simple but difficult to solve. It is a problem of supply and demand. The supply is too small, the needs too great, for all eligible drivers to get tires.

"It will take more time than we originally thought to supply 'B' card motorists and it looks as though there will be no tires for 'A' car drivers until early in 1945."

Pointing out that the July quota will be 450,000 higher than the May quota of 1,500,000 tires, Mr. Phillips said:

"The Office of Rubber Director is drawing on its reserves in order to raise the June figure to 1,950,000. The rubber director is doing this in order to clear away some of the backlog of unfilled requests for tires. Local rationing boards report that their quotas have allowed them to issue certificates for only about one-half of the bonafide tire requests they receive. The rubber director is helping us to meet this difficult situation. We hope to have it corrected later this summer."

Draw on Reserve Stocks

ORD, OPA said, allocated for July and August a total of 3,900,000 passenger tires which is all that OPA will receive during the two months for meeting requirements of "B" and "C" gasoline ration card holders. In order to supply so large a number of tires during July and August, ORD will continue to draw on its reserve stocks. ORD reported that current production is well below the passenger tire quotas set for June, July and August.

Reports from 70% of its local rationing boards, OPA said, indicate that about 733,000 unfilled applications from eligible drivers were on file with boards at the beginning of June. It is impossible to wipe out this backlog, it was pointed out, in a matter of days, or even weeks. But it is believed that the higher quotas will permit boards, during the next two months, to satisfy "normal replacement requirements" and substantially to reduce the number of unfilled applications. In emphasizing that replacements must be spread over a period of time, OPA said that motorists cannot expect to receive three or four new tires when one tire, along with a recap or two, will keep a car in operation for months.

Although the quota for large truck and bus tires (size 8.25 or larger) has been increased slightly for July, OPA said the number available for civilians is "far from enough" and it is realized that the supply will not keep all vehicles needing these large sizes in operation.

In an accompanying tire announcement on the same day, Rubber Director Dewey commented as follows on the truck and passenger tire situation:

"The difficulties confronting manufacturers to produce to the maximum of their facilities, plus large military demands for airplane tire and for heavy-duty truck and combat tires, prevent any forecast at this time regarding truck tires for the month of August. Present indications are that the August truck tire quotas will be substantially reduced."

A. P. Frame Replaces Cumming as Refining Boss

NPN News Bureau

WASHINGTON — Deputy PAW Davies this week announced the appointment of A. P. Frame, of Lake Charles, La., as Director of PAW's Refining Division, succeeding E. D. Cumming. Mr. Frame has taken leave of absence as vice president and chief engineer of the Cities Service Refining Corp., to join the PAW staff.

For the last two years, Mr. Frame has been in charge of the construction and operation of the Cities Service 100-octane refinery and butadiene plant at Lake Charles.

A. P. Frame

Commenting on the appointment, Mr. Davies said, "We are fortunate in obtaining Mr. Frame's services at this critical time when the nation's refining facilities are strained to the limit. He brings to the position an excellent knowledge of refining technology and many years of successful executive experience.

"To produce the great quantities of petroleum products that are needed to meet increased military and civilian needs at this time, the nation's refineries must operate at their maximum efficiencies. As director of the refining division, it will be Mr. Frame's responsibility to see that they do. He faces a difficult assignment, but I have complete confidence in his ability to carry it out successfully."

Mr. Frame was born in Wallace, Nova Scotia, and graduated from Dalhousie University of Halifax, in 1921. In 1924, he became plant engineer for the Empire Oil Refining Co., at Ponca City, Okla. From February 1927, to January 1928, he was refining engineer for the same company in Tulsa, Okla.

He was superintendent of the Pettys Island Refinery for the Crew Levick Co. in Camden, N. J., from January 1928 to September, 1938. Mr. Frame was assistant refining director of the Cities Service Refining Corp. from September 1938 to July 1942, when he became the corporation's vice president and chief engineer.

Mr. Cumming, who served as Director of PAW's Refining Division from December 1942 to June 1944, returned to New York City to resume his duties as vice president of the Shell Oil Co.

OPA Finds Proposed Flat Price for Residual Oil Is Hot Potato; Fears Trouble With No. 5

NPN News Bureau

WASHINGTON—It was a tossup this week whether OPA will back away from or go ahead with its recent proposal that No. 6 fuel oil carry the price now obtaining in the 13-15.9 gravity bracket and that the gravity scale residual pricing method now in effect be washed out.

Until only a few days ago, the stage was apparently set for the flat price proposal to go into effect about July 1. This would have increased substantially the price which obtained on No. 6 during the base period. The matter had been regarded as completely threshed out, since OPA's proposal was promulgated following a meeting here of members of four industry advisory groups set up several weeks ago to consult with OPA on the matter.

Briefly, OPA's proposal, which was sent the industry committees in Dists. 1, 2, 3 and 4 on June 5, would have done the following, besides setting a higher-than-base-period price for No. 6:

1. Permit the seller of No. 5 fuel oil to use either the proposed No. 6 price or his old base period price for No. 5, whichever was higher.

2. Permit seller to take, on "special" grades of fuel oil, either the suggested No. 6 price or apply to OPA for a higher price, showing special circumstances.

Districts at Odds

The entire proposal, it is understood, was acceptable to two of the industry committees, with minor revisions. But the other two committees, situated in the supply areas of the country, didn't quite cotton to the idea.

Some of the members of these two committees advised OPA that, besides a higher price for No. 6, they also wanted a differential above that for No. 5, pointing out that the industry historically has had a price differential on the two products and warning that absence of such a differential would have a markedly depressing effect on production of lighter fractions and perhaps even dry up the supply of No. 5 and other light fuel oils.

OPA has disagreed entirely with these arguments, pointing to the fact that the proposed No. 6 maximum price would, in many cases, be even higher than the seller's base period No. 5 price. Under such a situation, OPA says, there should be no depressing effect whatsoever on the production of No. 5.

However, these "warnings" by industry have taken on the characteristics of a "stop sign" to OPA, which fears that if the flat price proposal were put into effect and a shortage of lighter fractions develop later, it would be blamed for such a shortage and then be faced with alternative solutions, none of which would be agreeable to all involved.

Another good reason for OPA's desire to be on solid ground before proceeding is the fact that no formal directive or recommendation has come from PAW calling for such specific action as OPA has proposed on its own, after talking to the industry. Thus, if after OPA's flat price proposal were put into effect a shortage of lighter fractions should develop, the price agency would be completely on its own and could expect not even moral support from PAW—the supply agency.

Although there have been numerous "informal" conversations on the subject between PAW and OPA officials, no formal request has yet been transmitted by PAW, which the price agency could point to later if a shortage of light oils developed. And this is despite the fact that OPA has had a request for PAW's recommendation on the matter before the oil agency for nine months or more.

Held PAW Might Rule

At the moment, and pending a possible change of heart by industry on the No. 5-No. 6 differential question, OPA officials are said to believe the whole question can perhaps be better handled by PAW through use of specific directives to refiners. It is pointed out that PAW has directed refinery production of other products, such as war products, and only last week put into effect a cutback order on premium yield.

It is also understood, however, that some members of the industry, particularly in the supply area, appreciate the difficult problem that has been posed for OPA by the request of some for a price differential over and above the proposed increase in No. 6 price.

These members have asked the price agency to withhold junking the flat price proposal until they can consult with others in the industry and perhaps effect a bridging of the "differential" gap which so suddenly appeared.

Industry's request for a differential price between No. 5 and No. 6 is not the only factor, however, that has slowed OPA to a very careful feeling ahead on the question.

Numerous objections to a higher No. 6 price have been received by OPA from industrial consumers who complain that such action would increase their operating expenses. It is problematical how many of these have consistently been able to obtain fuel oil below 13-15.9 gravity and would truly have their fuel costs pushed up, but OPA officials agree there undoubtedly are some in this class.

Objections to its proposal have also come to OPA from those operating skimming plants which produce only the lighter fractions. Under the gravity-scale pricing arrangement which has been in effect for more than 18 months, these operators have realized a windfall, receiving a higher price for their product without having to blend or revise at all their operating mechanics.

Three New Oil Association Leaders Put on P.I.W.C.

NPN News Bureau

WASHINGTON — Three new members have been appointed to the Petroleum Industry War Council, it was announced by Deputy PAW Davies. The new members are Arch H. Rowan, of Dallas, president of the American Assn. of Oilwell Drilling Contractors; James W. Vaiden, of Tulsa, president of the Natural Gasoline Assn. of America; and Ferd Spang, of Butler, Pa., president of the Petroleum Equipment Suppliers' Assn. In discussing the new appointment, Mr. Davies said:

"Developments in the petroleum industry, particularly with respect to the use of natural gasoline components in the war program and the critical manpower and materials situation, make it advisable at this time to solicit the assistance and counsel of the three organizations and the limitless resources of experience that the membership of these associations possess in their respective fields. In accordance with the organizational plan of the Petroleum Industry War Council, the presidents of the associations are named to serve on the council."

F.D.R. Signs Price Control, Warns It May Be Tightened

NPN News Bureau

WASHINGTON—President Roosevelt this week placed his signature on a bill extending the Price Control Act but warned that, if enforcement officers encountered "serious difficulties" in bringing chiselers and black market operators to justice, "I shall ask Congress to remove the difficulties."

The President expressed his concern over provisions of the bill which relate to enforcement.

He was referring to new provisions in the act which relax penalties against nonwilful violators of price ceilings. He said he feared that the changes made "will weaken and obstruct the effective enforcement of the law," and added: "I hope that experience may not justify my fear."

On the whole, however, Mr. Roosevelt appeared satisfied with bill, observing: "Congress rejected all pleas which would require any general change in the wage, price and subsidy policies now in effect."

He added that during the past three months, while the act was under consideration in Congress, "the clamor of pressure groups was loud in the land," and added: "I think it is a source of gratification that in spite of this clamor the Congress has stood firm against any departure from the basic principles which have made it possible for us to hold the line."

The President said some of amendments in the act may make it "somewhat harder" to hold the line but added that the enforcing agencies believe the line can be held "against inflationary price increases if they are supported in a firm administration of the law in accordance with its basic objective."

STRIPPER VERDICT WAITED

(*Continued from P. 3*)

would be able to absorb the increase in price during the period of claim filing, and would thus be in a position to gather in more of the production from the stripper well fields.

One answer, apparently, would be for the government to pay the owners of the oil, instead of the "first purchaser," but this would be an administrative task almost impossible of efficient handling since there would be thousands upon thousands of individuals involved.

In contrast to this answer to the problem, NPN understands that only about 750 "first purchasers" will file claims with the government, as the plan now stands. Thus, the government agency given the physical job of paying the subsidies, would only have to make out 750 checks each month—a relatively simple task.

Also, this answer is given to fears expressed regarding the effect on the small refiner: If the refiner is so near the ragged edge in the way of operating capital that he cannot absorb an expense of a few thousand dollars for a couple of weeks, it is a wonder he is still in business.

In addition, it is pointed out, the refiner who finds himself in a tight financial situation should have no difficulty in obtaining a loan from his bank, giving as security the expected government subsidy check.

Fields Already Listed

The plan is this: OPA has already drawn up a complete listing of all of the fields involved, from data obtained from oil trade journals and state commissions. This data has provided the price agency with information as to the average daily production of each well throughout the country over the period from Jan. 1 to Dec. 31, 1943, inclusive.

From this data, OPA has determined those fields in which producers are eligible for an increase of 35c, 25c, or 20c per bbl. Fields in which the wells show an average daily production of 1, 2, 3, 4, and up to 5 b/d, are eligible for a 35c per bbl. increase; 5, 6 and up to 7 b/d, are eligible for a 25c per bbl. increase, and wells with a daily average production of 7, 8 and up to 9 b/d are eligible for an increase of 20c per bbl. In the Pennsylvania Grade area, covering Pennsylvania, southern New York, West Virginia and eastern Ohio, the increase would be 75c per bbl. regardless of average well production.

So, OPA's first move, if and when the subsidy program is approved, would be to insert in its crude oil price regulation the list of all the affected fields with their new maximum crude prices. The producer would look down the list for his field, determine his new price, and post that higher price from then on. There would be no other change in his operations. He would merely charge the purchaser the new price and receive payment in the same manner he always has.

NPN Summary of the Late News

Refiners' Renegotiation Parley To Be Held in Chicago July 13

CHICAGO—Dist. 2 refiners who had government war contracts amounting to $500,000 or more during 1943, which are to be renegotiated, will have an opportunity to hear a full explanation of the procedure to be followed and to have their questions answered by W. N. Widrig of the Reconstruction Finance Corp. price adjustment board, who will conduct a meeting in the Walton Room of the Drake hotel here July 13. O. D. Donnell, chairman of the Dist. 2 general committee, has sent a letter to all Dist. 2 refiners notifying them of the meeting.

Refiners who wish to have an advance look at the renegotiation procedure may do so by obtaining copy of RFC-PAB Form 25 from the RFC Price Adjustment Board, 811 Vermont NW, Washington 25, D. C.

OPA Favors FBI Probe of Cleveland Scandal, Emerson Says

CLEVELAND—In response to a request of the Cleveland Automobile Club, Thomas I. Emerson, Deputy OPA Administrator, has made clear that OPA desires to persuade the FBI to take charge of the investigation into Cleveland gasoline rationing scandal, which has diverted thousands of gals. of gasoline to the black market. In a telegram to John I. Young, secretary of the Cleveland club, Mr. Emerson declared that OPA has consistently tried to bring the FBI into the investigation "not because of any feeling that the investigation being conducted by OPA in Cleveland was not sufficiently vigorous or was being handled incompetently, but rather because we felt that as a matter of public confidence some outside agency should take responsibility for the investigation".

Twin Cities Oil Transport Drivers End Strike

CHICAGO—Petroleum transport drivers in the St. Paul-Minneapolis area called a temporary halt to a strike involving some 150 trucks and went back to work July 5 pending a decision from the War Labor Board expected early next week. This was reported here by ODT officials. The drivers made the decision to return at a meeting July 4. The issue involved in the dispute is one of conflict between two September decisions of WLB which gave drivers for a group of independent operators 93c an hour for a 48-hour week, plus time and one half for overtime, while drivers for three "for-hire" operators were given 93c an hour for 40 hours with guaranteed 6½ hours overtime at time and one half.

Ohio Oil Leases 150,000 Acres in Florida from Sugar Firm

CLEVISTON, FLA.—The U. S. Sugar Corp. has leased oil, gas and mineral rights on approximately 150,000 acres on the southern shores of Lake Okeechobee, Florida, to the Ohio Oil Co., Clarence R. Bitting, president of U. S. Sugar, announced this week.

ODT Now Rationing Agency for New Commercial Vehicles

WASHINGTON—ODT this week started issuing certificates for the purchase of new commercial motor vehicles. The move was authorized under a new program which places the rationing of such commercial equipment solely in the hands of ODT on and after July 1. In order to facilitate action on pending applications, experienced personnel was being transferred from the rationing and inventory branch of WPB to ODT.

Persons wishing to obtain new commercial motor vehicles must file applications for certificates of transfer with the ODT district offices nearest their home offices or principal places of business. The application forms will be supplied by ODT, but it will be permissible, until Sept. 1, 1944, to use form WPB-663.

ODT Orders Preference for Tank Car Shipment of Products

WASHINGTON—Due to sharply increased military demands for fighting grade aviation gasoline and other petroleum products, ODT Director Johnson on July 5 notified oil companies that tank car loadings of oil products must be given preference over all other tank car shipments. At the same time, the director instructed railroads to transport these shipments with the greatest possible speed.

Fuel Oil Dealers Warned to Make Certain Coupons Are Signed

WASHINGTON—OPA this week warned fuel oil dealers to make certain that coupon ration sheets are signed (endorsed) before accepting them for deposit. Otherwise, OPA said, dealers must return the unsigned sheets for signature, which involves unnecessary work. The agency suggested that when dealers are urging customers to order fuel early that a reminder be attached to letters, pointing out that the customer must sign coupon sheets. All employes should be instructed to examine coupon sheets carefully for signature, OPA said.

PIPELINES—*Views of the Industry's Problems a*

Washington— *Opening "B" and "C" Lists to Public a Smart Move* —By James Collins

WASHINGTON—At last, OPA is going after over-issuance of gasoline ration coupons in what presently appears to be a common-sense way—that is, allowing the lowly "A" card holder, among others, to get a real close look at the ration board mileage applications of his brother "B" and "C" card drivers.

Of course, besides any private citizen being permitted to examine supplemental gasoline ration applications at local boards, newspapers will also have full access to gasoline ration files. OPA has an idea that they will not be at all loath to digging into the records for cases of flagrant abuse and then printing the subjects' names, amounts of mileage granted —or asked for—in prominent spots in their pages.

Philosophy behind the idea, obviously, is that none of the gasoline rationing elite—the war worker, the public official, or what have you—will dare ask for more than he actually needs because there will always be the chance that the fellow across the street, who is squeezing by on two gal. a week, will take a gander at the mileage application of the aforementioned—and raise a big squawk if anything is out of line.

OPA plans to get the idea operating within the next week or two. It will send instructions to each local board that it is to permit any person to examine the mileage demands made by an applicant after June 30. Originally, it was planned to also instruct each ration board to post a notice in some conspicuous spot so that John Q. Public would know what was coming off. But it appears now that this will probably just be suggested to the boards. National headquarters hopes, however, that most boards will tack up such a sign.

° ° °

Although it was several weeks ago that this writer was given to understand by several OPA officials that the general ban on exchange of "R" coupons at service stations was due for a very quick and painless death, Amendment 111 is still lustily alive on the gasoline rationing order books.

It seems someone got inordinately cautious and decided that a careful survey should be made of the industry, to see what the views were of individual companies, OPA industry advisory members, and others. So, telegraphic queries were addressed to members of the industry asking their reaction on the "R" ban, before July 1.

The box score at this writing runs something like this, so we understand:

Herbert A. Yocom, chief of NPN's Washington bureau, is on vacation. The Washington column this week is written by his assistant, James Collins.

For revocation of the ban—14; for keeping the ban, or even tightening it—6. Lest some readers surmise that the six favoring retention or more stringent application of the ban are all "big fellows" and the others all "lil' fellows," we point out this interesting fact: several of those *for* revocation are in the topsize bracket and, altruistically, even go so far, we hear, as to point out that diversion of business away from the small operators has resulted, should be stopped, and corrected.

With this strong substantiation by the industry of OPA's original opinion, the cards look to be stacked for an early demise of Amendment 111, and substitution of some other method for controlling the flow of "R" coupons—which have been the biggest potential in the black market.

° ° °

Here's one of the $64 questions extant hereabouts at the moment: "Is Shad Polier (his title is OPA Fuels and Durable Goods Enforcement Director, although we have an idea you, the reader are fully acquainted with it) leaving OPA and how soon?" The second part of the question appears, naturally enough, to be its nub.

Rather than fish around among his friends for the answer, we went directly to the enforcement chief and put the question to him exactly as quoted above.

His answer: "Why yes, I am planning to leave in a couple of months, for family reasons." We forgot to ask if he meant "Polier family reasons" or "OPA family reasons." But we would wager that the truth lies somewhere in between the two.

° ° °

One more item on OPA and then we're through.

This one deals with the possibility of naphtha rationing—if and when, where and how.

Problem of naphtha rationing has been kicked around from pillar to post for months, with each of the two agencies directly involved—OPA and PAW—rather hoping that the gadfly would either start behaving itself or die.

When some sort of concrete action finally had to be taken, it came from PAW, in the way of the naphtha allocation order that set up quota rules, etc. But, the order has failed miserably because PAW, with its limited field staff, hasn't had the men or facilities to do a thorough job of checking into applicants' exception appeals with the result that nearly everyone who asked for more than his quota, on an appeal, generally got it.

Atlantic Coast— *Meeting on "Dealer Quota" Plan Stirs Lively Interest* —By Frank P. S. Glassey

NEW YORK — The so-called "Baltimore Plan" to increase gasoline rations in an effort to eliminate the black market may actually have a tryout, in conjunction with another proposal to establish dealer quotas for motor fuel. A PAW Dist. 1 marketing subcommittee will meet Friday of this week with three retailer representatives who hope the program will be approved, at least for a limited area along the Atlantic seaboard.

Mr. Glassey

The retailers have been waging their campaign for several months but seemed to make no progress until last week when it was revealed that the Dist. 1 marketing committee is seriously considering suggestions for dealer quotas. No predictions are being made by the retailers, who are keeping their fingers crossed after Friday's parley. But there is just a breath of optimism in the air.

A. C. Bedford, of Standard Oil Co., of New Jersey, W. L. Faust of Socony-Vacuum Oil Co. and J. A. Kelley of Cities Service Oil Co. will represent the marketing committee; John Dressler of New Jersey, Frederick H. Moore of Massachusetts and Harry Wainwright of Washington, D. C., will be spokesmen for the retailers. Harry B. Hilts of the Empire State Petroleum Assn. is expected to attend as an observer.

PAW and OPA both weighed the dealer-quota proposal a few months ago, together with the "Baltimore plan", which would increase ration allowances to approximately the amount of gasoline estimated to be absorbed currently in the black market. The original sponsors urged a test of the scheme in the Baltimore area, which can be fairly well isolated. Thus far they've been greeted with nothing but cold skepticism in official quarters.

Backers of the quota plan assert that by regulating the movement of civilian gasoline through distributor to dealer, there will be no supplies available for the black market. They also argue that if a dealer's sales are limited on a quota basis, he will have no incentive to deal in the black market, since his

entire quota can be sold in the normal manner.

Mr. Dressler, representing the Eastern States Gasoline Dealers' Assn., is too cautious to venture an opinion as to the outcome of the retailers' drive, but he was emphatic in declaring that some such plan should be given a trial.

"Coupon rationing is not working," Mr. Dressler said. "The best evidence is the fact that New York State tax returns for the first three months of 1944 showed a 12 per cent gain in revenue from gasoline taxes, as compared with a year ago, despite the curtailment in allocations to consumers. A similar comparison for Pennsylvania revealed a 13 per cent advance in tax collections on motor fuel."

* * *

Gossip and rumor had a joint holiday here last week. The result was temporary disruption of service-station morale.

The cause was a report—no one knows where it originated—that the Port Authority of New York planned to enter the petroleum marketing industry by establishing cut-rate service stations throughout the metropolitan area.

The tale spread over the city's service station operators by the familiar grapevine and soon assumed grandiose proportions. The insiders had it from the horse's mouth that the Authority was going to set up 40 stations in each borough —200 in all——to sell gasoline to commercial consumers at a discount of anywhere from 2.5 to 5 cents a gallon.

The Authority is not a municipal institution, but a corporation operated by the States of New York and New Jersey. It supervises interstate bridges, tunnels, etc.

As the rumor grew, its versions varied, but all agreed that the New York State Legislature had enacted and Gov. Dewey had signed a measure authorizing the Port Authority to compete with private business in the oil industry. Dealers deluged the Authority with letters of protest, while one large dealers association began plans for a mass meeting.

One of the more amusing aspects of the furore was a letter received by the Port Authority from an attorney, written on the stationery of a garage owners' association, in which the lawyer, as counsel for the association, denounced proposals for the Authority to open a chain of service stations. On the same day another letter arrived from the same attorney, on his private stationery, asking if he could obtain the concession for operating the chain of service stations for the Authority.

Austin Tobin, Port Authority executive director, said this week that the hubbub was an extremely annoying teapot tempest.

"We have no more intention of going into the oil business than we have of selling groceries," Mr. Tobin said. "I don't know how the rumor started. Perhaps it arose from the fact that the Authority sometimes has excess land. One such plot in New Jersey is rented to a gasoline station. That's the extent of our petroleum activity, and so far as I know there's no chance of it spreading any further."

Midwest— *Serious Tank Car Shortage Facing Dist. 2* —By Earl Lamm

CHICAGO—After a two weeks vacation in the Southwest and a week of perspiration in the hot sun and Republican politics, thoughts return to the oil business.

Mr. Lamm

A checkup of happenings meantime indicates that the Midwest is heading into the worst tank car situation since the war began. Heavy draft of cars for West Coast service and for military products elsewhere, plus a considerable number of cars on the bad order list due to wear out and breakdown are due to make transportation problems tough. Also, there are fewer boats and barges on the Great Lakes this year than they were in 1943, as some brought in last year are now being used along the East Coast to distribute products transported through the Little Inch pipeline or made from crude put through the Big Inch. Further, Dist. 2 motor gasoline stocks are about 2,000,000 bbls. higher than a year ago and there is likely to be a call for it by Dist. 1, which will bring demand for more tank cars for that movement.

However, the Sinclair products pipeline from Chicago to Toledo, which should mean some saving in tank cars, right now is carrying only a fraction of its capacity due to various complications which need, and probably are, being ironed out. Second hand pipe used in its construction won't stand the pressure of 30,000 b/d capacity operation, but would take about 26,000 b/d if the products were available. One difficulty is said to be that the 1% line loss (3c a bbl.) is not compensable by DSC unless the products go to Dist. 1. Sinclair's application for two line take-off terminals west of Toledo for distribution of products locally have not yet been approved by PAW, and one they asked for, located near Westville, Ind., has been refused, although it is contended that facilities for moving certain products east from Toledo are inadequate.

July pull on motor gasoline stocks in Dist. 2 and 3 it is anticipated will average about 50,000 b/d each. Take for the military products pool in Dist. 2 during this month remains at 24%, the same as June, although requirements of 702 Navy Diesel dropped slightly to 40,000 b/d. Order for 60,000 b/d of 80 oct. all purpose gasoline is being filled.

However, these and other heavy drafts on Dist. 2 supplies, including the 50,000 b/d marked up for reduction of motor gasoline stocks may be slow in being felt because of increased refinery runs of crude, which picked up immediately following PAW's relaxation of 80% restriction on runs for June. Week of June 10, runs averaged 1,184,000 b/d, June 17, 1,204,000 b/d and June 24, 1,199,000 b/d. This appears as concrete evidence of the effect government restrictions are having on the oil industry. Industry will find a way, if government will let it. Oil men are patriotic but there will always be a difference between whole-hearted endeavor and mere ordered compliance. There is little doubt but that PAW's new easing of drilling and material restrictions will have a wholesome effect in further increasing the production of crude, and if OPA would meet this challenge with a similar price adjustment the way would be open abandonment of many industry quarrels with government.

During our vacation trip to the Southwest, we made some incidental personal calls on oil men friends and for Deputy PAW Davies' information should he happen to see this, were told quite truthfully that the Southwest does not want complete abandonment of PAW at this time. What was wanted prior to his meeting with Dist. 3 operators on June 15 and what will be looked for in the future, is continued, if gradual let up of restrictions such as recent relaxation of PAO-11 whose restrictions long had been irksome to the Southwest.

As for increased crude runs in Dist. 2, it is human nature to do nothing more than fill orders when extra crude must be shared with other refiners at present low prices—prices lower than replacement cost. Only about 15,000 b/d of compensable West Texas sour crude was brought into Dist. 2 last month, and it's not likely that this amount will be greatly increased soon because of tank car shortage and because refiners who need more crude don't want it and are not equipped to run it, expressions to the contrary notwithstanding.

PERCHLORON
A Stable Calcium Hypochlorite Powder for use as a Bactericide and Deodorant
PENNSYLVANIA SALT MANUFACTURING COMPANY
Chemicals

WATER FIT TO DRINK...

Keeps men fit to fight!

Running water on a battlefield is usually water running down the side of a slit trench. And that's not exactly drinkable!

So wherever our Army advances, the Corps of Engineers goes along to provide a water supply safe for a thirsty man to drink. Right up to the very front go the engineers and their mobile water purification units . . . seeking out the best water to be had . . . and then making sure it is safely purified.

PERCHLORON, product of the Pennsylvania Salt Manufacturing Company, is the source of the chlorine used in many cases. Due to its high chlorine content, a can of PERCHLORON can do a big job . . . since there is no significant loss of its strength and effectiveness en route. A specially designed Crown Can . . . a controlled breathing *resealable* container . . . provides protection in shipping and during use.

That's one more Crown Can that goes right up to the fighting line . . . another product of Crown's assembly lines doing its part to speed the day of Victory.

★ ★ ★ CROWN CAN ★ ★ ★

CROWN CAN COMPANY • NEW YORK • PHILADELPHIA • Division of Crown Cork and Seal Company, Baltimore Md.

Enlist the Churches and Organized Religious Groups In Drive for War-Law Compliance and Enforcement!

TO GIVE THE PEOPLE OF THE COUNTRY the names of all those seeking "B" and "C" gasoline coupons and the reasons why these claimants think they are entitled to such motor fuel preferment, is one of the most forward looking decisions OPA has yet made. That decision was to have gone into effect July 1st and, while it has not been published as this is written, it is greatly to be hoped that OPA will go through with it.

The idea, we believe, was that of Col. Bryan Houston when he was chief rationing officer. This was not the only good idea that the colonel had and was trying to get into effect for the improvement of OPA when he was suddenly "recalled" or "sent back" to the Army.

But making the information public and actually getting it to the public are two different things. However, if OPA really wants the assistance of the honest and non-chiseling gasoline users in enforcing gas rationing, it can get it. Undoubtedly the best way to give this information to the public is through the newspapers. But there are some twenty million such names and newsprint paper is short. However, the problem of working this out, at least in part, through the newspapers is not insurmountable if OPA really goes to work on it.

Names are always NEWS and especially when there is a suspicion of wrongdoing in connection with them and that is exactly the average "A" coupon holder's thought in connection with every holder of tokens for larger gas rations. OPA cannot call such lists "suspicion" lists but when OPA causes them to be made public it also asks the public to scan these lists to see if every one is entitled to the extra gasoline he has asked for, and to see if the reasons he sets forth are true.

That tells every reader that if he studies these names he may find wrongdoing against himself and the country's war effort.

That will be sufficient to get the long suffering 2 gallon a week "A" coupon holders busy.

That will also get the co-operation of the really honest "B" and "C" coupon holders who resent the cloud that is placed on them and their display of these preferred gasoline emblems by the chiselers. The only way the honest "B" and "C" motorists can remove the cloud is to help ferret out the cheaters and get them reduced to the "A" class or, better still, have them deprived of all gasoline for the duration.

It should be easily possible for OPA and the White House to get the newspapers to print at least a reasonable number of these names. Even every tenth or hundredth name would help. But it may be possible, if the administration really worked at it, to get the papers to print practically all of the names by dedicating say a column a day and dividing the names among the newspapers in the area. In fact, let some of the large space now being devoted to war bond and other patriotic advertising be devoted to this cleaning out the gasoline chiselers. The actual message in most of this patriotic advertising copy could be just as well displayed in less white space.

To do all this OPA could, and should, organize a great national campaign to build public opinion for 100% honesty for all war regulations. Such a campaign OPA radicals and lawyers never have attempted because, seemingly, they cannot star in "practicing law" or politics, except when they are cast as prosecutors especially as prosecutors of the small and weak who do not maintain staffs of hard-boiled lawyers who know how to fight New Deal shyster tactics.

Complying with war regulations—that is, all fair and lawful and honorable ones—is a matter of personal righteousness, the kind of innermost uprightness that most Americans have been taught in home, Sunday school and church. Today these same Americans are thinking of the Power that Guides and Protects more perhaps than ever before in their lives. Their hearts and minds are so attuned to the stresses and hazards of the times that they can be reached as never before, in any cause that will help and strengthen the efforts of their own who are taking the brunt of the battle on the fighting lines.

The OPA, backed by the entire administration, should enlist the right thinking and right doing people through their churches, then through their other social organizations, the women's clubs, social service groups meaning such as the Y.M.C.A. and commercial organizations. It may seem a bit incongruous for some of the more calloused and communistically tainted New Dealers to go to the churches for help but perhaps those New Dealers will have the good grace to stay in the background and let the church members of the New Deal do the job.

Teaching the people the evils of sin has been the task of churches and religious groups since the beginning of time. Arousing the people that gasoline, food and all war regulation cheating is sin, also belongs to the religious groups. Cheating in rationing is lying, stealing and doing unto one's neighbor as he does NOT want to be done by, just as much as any of the other crimes that are condemned by the Ten Commandments.

If memory is correct, the organized religious groups, as such, have not been enlisted in this war effort by the New Deal. Ministers, priests and rabbis have been given places in the armed forces and Mr. Roosevelt undertook to lead the nation once with his own prayer. But the great organizations that have grown from men's hearts and the wish to do right, and which have made such great and lasting contributions to mankind, have, we should say, largely been left out of the war effort.

But here is where they can be properly enlisted and here is where they can do a real job, that of arousing the people to a gigantic effort for all war law compliance and enforcement. The need to yourself, to your family with the armed forces and to your God, of playing square with all, should be thundered from every pulpit, not just for one "compliance week" but Sunday after Sunday. The text that "Thou shalt not steal", nor lie, should be interpreted in countless thousands of sermons and prayer meeting talks, to also mean that thou shalt not take gasoline that belongs to your neighbor and to your boy overseas. Hearts that are aching or are in fear for those overseas will respond at once and relentlessly to such an appeal.

It should be a simple matter for OPA to contact all these national forces for good. These forces are represented by national committees and boards. There are national papers and even state and local papers reaching their members, even every week.

The best approach, probably, would be through the General

READERS' comments and opinions will be much appreciated by Warren C. Platt, NPN's Editor and Publisher, Penton Building, Cleveland 13, Ohio.

Staffs of the Army and Navy for they alone, of the multitude of agencies at Washington, have clean reputations, for the most part, of not playing politics. They also have been generally recognized as telling the truth, whereas a large number of those active in some of these New Deal enterprises are not only publicly accused of chicanery and falsehood and even worse, but, we would say, stand convicted of such.

However it may be handled, the movement must be kept absolutely clear of all suspicion that it was started in order to aid the New Deal and its fourth term candidate. Perhaps it is possible for OPA, for illustration, through the General Staffs to present the proposition to the national religious groups and then stand entirely aside while they work out the problem. Or, perhaps, there are individuals in these Washington organizations who could privately present the subject to those in these groups whom they may know and thus keep politics out of it entirely?

The need for this patriotic and righteous invasion of a function of government is greatest in gasoline, fuel oil and tire rationing because, in these, government of necessity must undertake to discriminate between those who need transportation and heat the most in the best interest of the war, and those who need them the least. With food and shoes and such, all are treated equally. No matter how honest and fair the administration of this necessarily discriminatory rationing such as gasoline, undertakes to be, there will be some injustices.

Only by an enlistment of the good people of the country, can the evils of this rationing be overcome, at least in part, and only through their active and hearty enlistment in a campaign of righteousness the country over, can all rationing be kept from becoming a farce and a cesspool of political and other corruption.

Lastly, and decidedly not incidentally, the country needs gasoline and fuel oil for its war effort, out where the fighting is, more than ever. That need is more likely to increase rather than decrease, and the administration's studied policies still prevent the oil industry from getting enough for the whole country's war effort.

Could not each reader of this editorial, consult his pastor, reader, priest or rabbi, about this idea? Let us know what he says and you think.

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Fishing Trip Ended but Gasoline was Wasted!

TO DATE no one has been arrested and sent to jail for a strictly non-war use of gasoline and it is a safe bet that they won't be.

This morning's Cleveland paper chronicles a fire in a motor launch in which four men were going to spend the Fourth of July holidays on a private, non-war fishing expedition off Marblehead, 70 miles west of here on Lake Erie. Fire started from gasoline that overflowed as they prepared for the admitted pleasure journey. Firemen estimated $2000 damage was done and one man was given hospital treatment for burns.

The strictly pleasure trip was called off but the gasoline that belonged to honest and patriotic "A" coupon holders was burned up anyway.

What will OPA and ODT do about this and probably many thousand other motor boat owners who enjoyed, for non-war purposes, their neighbor's gasoline?

Phillips To Head Bates College; Leaves OPA Post by Fall

NPN News Bureau

WASHINGTON—As a result of the appointment as president of Bates College in Maine by its trustees a few days ago, Charles F. Phillips, OPA deputy rationing administrator may leave his government post within the next 60 or 90 days.

Mr. Phillips told NPN that he expected to remain with OPA as long as OPA Chief Bowles needs him. In a formal statement prepared by OPA in answer to reporters' queries, the agency expressed its appreciation to Bates College for allowing Mr. Phillips to remain with OPA "until sometime later in the year."

Letter from NPN Reader

Defends Phillips' Record in Rationing Enforcement

FROM: Mr. Russell A. Keck, Kendall Refining Co., Bradford, Pa. TO: The Editor.

Dr. Charles Phillips appears to be the target of criticism for a number of people and I fear in many instances unfairly so, because they apparently are not armed with first hand knowledge of the person in question. It is easy to say "Henderson holdover" or a member of the "Henderson Clique" and thereby create in many readers' minds, misconceptions because of the brand labeling.

In fairness to Dr. Phillips I would like to point out that my opinion of him is, he is a very fine gentleman—eager, willing and desirous of learning, through discussion and counseling with industry men, what should be done to alleviate rationing problems and make industry's job easier.

He is always courteous and fair. He leans over backward at Industry Advisory Council meetings to explain what their purpose is in any proposal they seek advice on, and does everything to encourage full discussion of the questions and subsequent recommendations. If they are at variance with his ideas he agrees to take them under advisement for further consideration.

Frequently he writes letters posing problems and asks for frank answers.

I base my opinion of Dr. Phillips on seeing him work ever since early 1942. I have sat in on the council meetings as a member since its inception and each time my regard and respect for him increases.

To the best of my knowledge his door is always open to oil men and he is never too busy to listen and discuss with them their problems or criticisms.

He has always been in the market for good industry men. You carried an article in your May 31st issue stating he was looking for four good oil men.

The appointment of Q. W. Regestein as chief of gasoline rationing is a splendid example of picking the right men.

Another illustration of his policy of discussing pertinent matters with the Industry Advisory Council was the point he made before the Lea Committee in May, wherein he stated he was working closely with the committee on the question of revision of certain enforcement practices. This matter was thoroughly discussed at our meeting a week or so after the Lea Committee appearance.

It is true that he has made mistakes, but when discovered he has been quick to admit them and to take steps to affect a remedy. And, that is a whole lot more than some others in authoritative positions do.

I wanted you to know, Mr. Platt, that at least I don't agree that Chuck Phillips is a "long hair". I've seen too much of him at first hand.

Diesel Engine Builders Rally, Plan Campaign of Education

NPN News Bureau

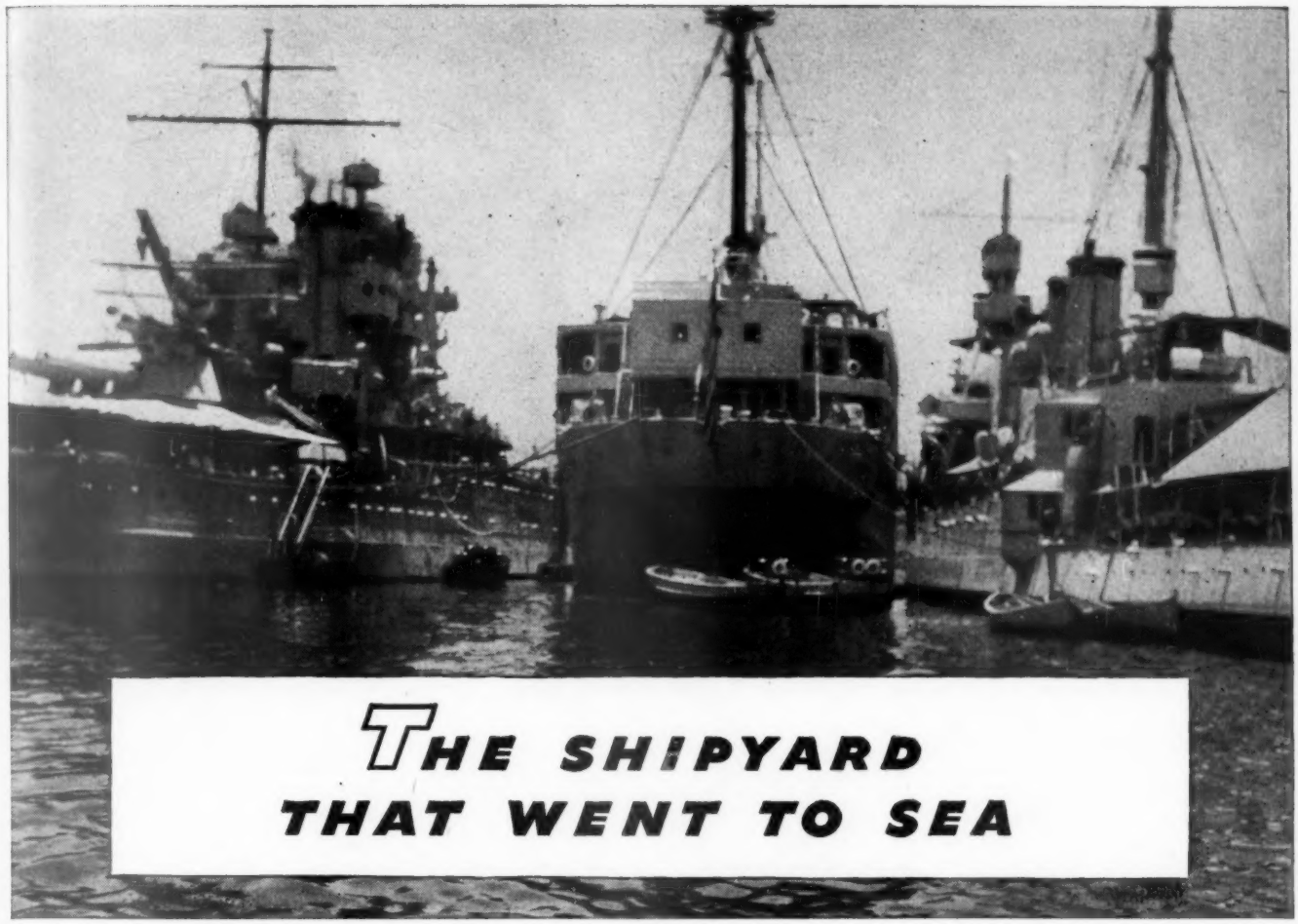
NEW YORK—Increased public education in Diesel engine use was urged last week at the annual meeting of the Diesel Engine Manufacturers Assn., whose directors appointed a committee to encourage and cooperate in Diesel study in colleges and universities, and another to foster public relations work. A third group was named to combat proposed increases in freight rates.

Thirty-eight manufacturers from all sections of the United States attended the one-day meeting at which Robert E. Friend, association president, was chairman.

Gordon Lefebvre, president of Cooper-Bessemer Corp., was selected as head of the committee to stimulate college studies, and it was announced that 140 colleges or universities already had such courses or would install them immediately after the war.

E. J. Schwanhauser, vice president of Worthington Pump & Machinery Corp., was named to lead the committee opposing freight-rate boosts. Robert H. Morse, Jr., sales manager of Fairbanks, Morse & Co., was appointed chairman of the body dealing with public relations, which will soon call a meeting of advertisers, public relations representatives and promotional specialists of member companies.

Guest speaker at the annual meeting was Thomas H. Beck, president of Crowell-Collier Publishing Co., who reviewed the enormous increase in sales of Diesel engines during the war and summed up potential gains when the war is over.



THE SHIPYARD THAT WENT TO SEA

ON THE HIGH SEAS . . . *America's great battleships are followed by tenders.*

When one of our Navy's ships is crippled at sea, the repair tenders are close behind, ready to put the ship back in fighting shape! Then, the warship can go back into the battle as tough as the day it left port.

To the tenders goes much of the credit for our recent destruction in Japan's front yard. And they will be in the fray when America's battlewagons square off before Tokyo.

BELOW THEIR DECKS . . . *these repair tenders are miniature shipyards.*

Practically any shipyard shop has its counterpart below the decks of these busy tenders. No matter what damage is to be repaired, there is a shop to handle it. The petroleum industry is just as much at home aboard these tenders as in America's war plants. For petroleum manufacturers supply the oils that run these ships, lubricants, and the other petroleum products used in the maintenance and repair of parts brought aboard.

Indeed, the Petroleum industry enters into every phase of modern warfare. Gulf is proud to be a member of this fighting industry.

GULF

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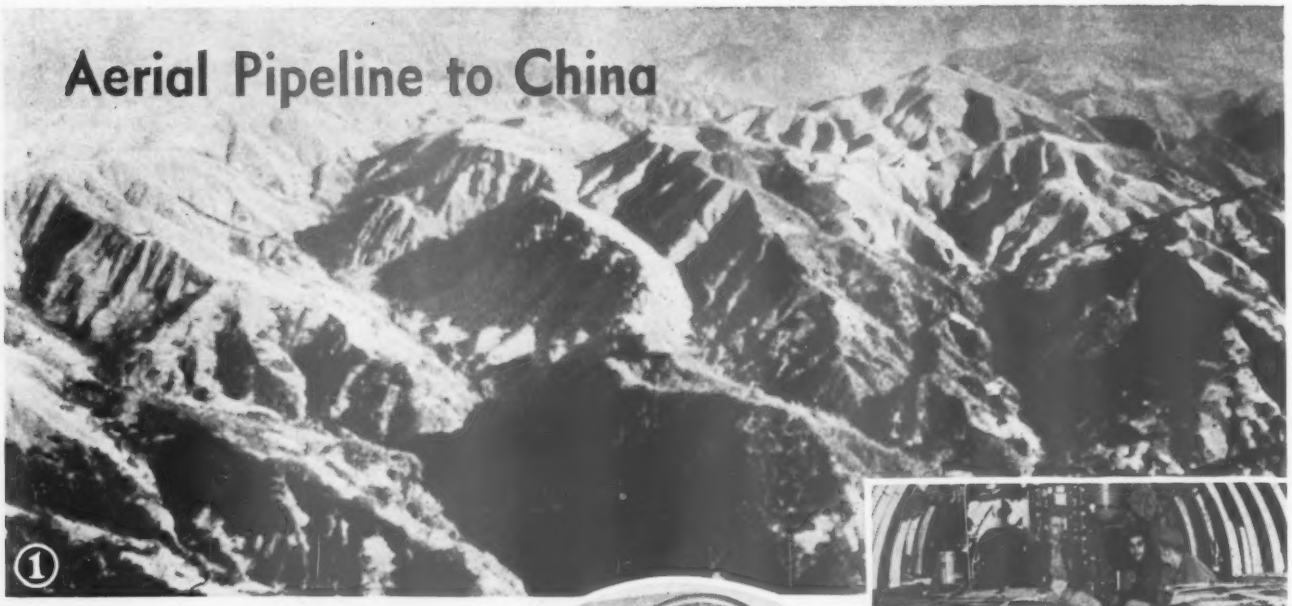
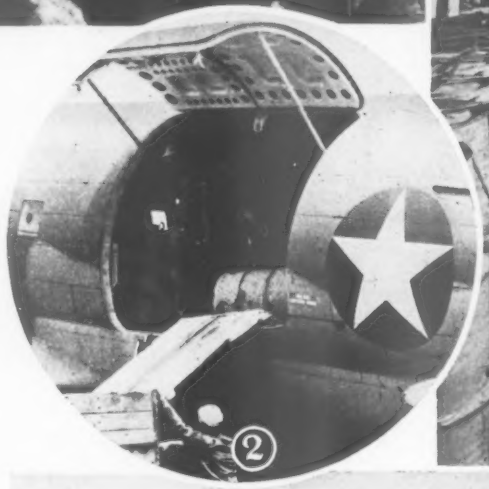
Aerial Pipeline to China





Big Transport Planes Carry Vital Petroleum Supplies Over Perilous 'Hump' of Himalayas

Special to NPN

BUFFALO—Out of the bosom of India and over the lofty and formidable peaks of the Himalayas runs an "aerial pipeline" which carries vital petroleum products daily to the Chinese war theater.

The vital products carried over this route are not, strictly speaking, confined to the narrow limits of pipe. Rather they are confined to the ingenuity of man. And bringing the supplies to their destination in China depends upon the bravery and ability of the pilots who fly the petroleum products over this most treacherous route in the world.

The "aerial pipeline," which has justified meeting the dangers presented by the barren peaks of the Himalayas, as well as weather and pressure hazards, has made possible carrying the war to the Japs. The supply line is operated by the U. S. Air Transport Command, from bases in Assam, India. And from those bases 100 octane gasoline and petroleum products are carried to the U. S. Fourteenth Air Force in China.

This fuel supplies the means for blasting at the Japanese in occupied sections of China, and for smashing at the very back door of Japan. More lately this dangerous supply route provided the means for the Super-Fortress raid on the great Japanese steel center in the home Japanese islands.

The largest air line operation in history, ATC aircraft carry thousands upon thousands of barrels of aviation gasoline and oil over it. Three-fourths of the aircraft engaged in flying the dangerous "hump" are Curtiss C-46 Commandos, largest twin-engined transports in the world. And in addition to the fuel carried by these planes, heavy guns, jeeps and other vehicles, light artillery, field rations, small arms, blood plasma and personnel are taken into China in the same manner.

But among all supplies flown into this theater, petroleum products are, by a wide margin, the most important of all.

Photos Courtesy Curtiss-Wright Corp.

1. An aerial view of the Himalayas, whose rugged, towering peaks are a constant source of danger to the aerial pipeline to China. A landing in this terrain means a lost plane. Japs are an ever-present menace, too

2. Gasoline drums are unloaded from a C-46 in Kunming, China, after the first flight of a Commando over the Himalayan "Hump" from India

3. En route over the "Hump" from India to China is this crew of a Commando. They are delivering 23 drums of 100-octane gasoline to the 14th Air Force. Countless trips like this supply our fliers in isolated China

4. Illustrative of the difficult operating conditions in the India-China theater is this Curtiss Commando landing on a muddy, unfinished field in China. These planes usually operate at a gross weight of 50,000 pounds

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Indian laborers under supervision of an American soldier roll drums of gasoline into a truck at a base in India, whence they will be loaded into a Curtiss Commando for the dangerous flight over the Himalayas to a Chinese field

Without them the valiant Chinese would be isolated and alone in her war against the Japanese invader. And without them, the Super-Fortress raid on Japan's great steel center could not have been carried out.

Flying conditions over the "hump" are always rigorous, but the ATC planes continue to operate, even in bad weather. Every plane flying the route is troubled with vapor lock in the fuel line. Tropical heat at ground level, unusually warm air between 18,000 and 20,000 feet, low air pressure at high altitudes, and circuitous fuel lines are among major sources of trouble. Solution to the vapor lock problem was found in the Curtiss-Wright Laboratory at Buffalo, N. Y., where an entire fuel line was set up and operated under conditions which simulated actual circumstances in the altitude chamber.

The Commando planes which fly the route are manufactured in four Curtiss-Wright plants—two in Buffalo and one each in St. Louis and Louisville, and at Higgins Aircraft, Inc., in New Orleans.

More than a year ago a large number of Commandos flew from the United States in India in approximately four and one half days, the largest mass flight in history. Then was inaugurated the Commando operation over the high Himalayas.

Kentuckians Hear Top Steermen of I.P.A.A. Warn Independent Oil Man Is Facing New Battle

Special to NPN

LEXINGTON, Ky.—A call for government to resume its role as a referee and not as participant in the industrial world was made here last week by Russell B. Brown of Washington, general counsel of the Independent Petroleum Association of America, at the annual meeting of the Kentucky Oil and Gas Assn.

"We want the umpire out in the middle of the diamond giving the decisions, and not pushing the pitcher or the batter out of the way," Mr. Brown asserted.

Citing as examples the activities of the Army, the Navy, the Department of Interior and the Department of Agriculture, Mr. Brown said: "The referee has moved far from his original assigned role."

He pointed to the Army's Canol project and its desire to expand and develop other similar programs, the Naval Reserve operations, the working arrangement the Department of Interior has with the Army, the Agriculture Department's proposed oil-drilling and federally sponsored experiments in making liquid fuel from coal and oil shales.

"Controls will continue until the war ends, but we are now beginning to hear the voices of certain agencies asserting that in the postwar era it would be ruinous to let the people go back to their 'undirected way' of doing things," he concluded. "It then becomes our duty to make our elected representatives aware of our wishes in the matter. We must not let the present world conflict be made the occasion for the loss of the liberty which we are told we are fighting to guarantee elsewhere."

At the same session Ralph T. Zook, president of the I.P.A.A., asserted that the biggest job faced by the nation is to find employment for the man who will soon be returning home from fighting a world war. The task must be done, he said, but the oil industry cannot do its part if a definite government policy exists of making money, manpower and materials available to the oil industry in foreign countries.

Oil reserves of the Middle East, he asserted, are "of sufficient magnitude to supply world requirements many times over," duplicating a situation that faced the independent oil producer in the United States 15 years ago, when the independent oil man was confronted with the same import problems that will face him at the end of this war.

"He won that battle; and he must win the next one," Mr. Zook said. "Nothing is gained by ignoring the situation that will develop.

"The independent producer has fought continuously against monopoly, bureaucracy and confiscatory taxation . . . He has been compelled to build with one hand and carry a defensive weapon in the other.

Holds Price Relief Needed

"Today the independent faces the combination of forces which have been battling him for years. He cannot quit. He must go on."

N. W. Shiarella of Owensboro, retiring president, guided the concluding session of the two-day meeting. In his annual report he praised members of Congress who tried to have recently-passed OPA legislation amended to include a crude oil price increase.

Mr. Shiarella said Kentucky oil men needed the price boost badly and that the "labor lobby" worked against the amendment. The Disney Bill, which provided for a 35c per barrel increase for crude, passed the house but is being held up by the Senate Banking and Currency Committee, he said, adding that a government subsidy plan for stripper wells had been worked out that will be put into operation as soon as governmental financing can be arranged.

Jake Sandefer, Jr., of Breckinridge, Tex., president of the National Stripper Well Association said that petroleum was a key in the strategy of the war and that more than half of overseas shipments for war use were oil and oil products.

"The invasion force rides ashore on a wave of oil," said the Texan. He emphasized the necessity of the stripper well operators receiving relief through a price increase or, as a last resort, by subsidy.

"Many operators are using stripper wells today despite the fact that they are operating at a loss. They are doing this and will continue to do so if it will help win the war," he said.

Mr. Sandefer spoke at a June 24 luncheon session which followed technical addresses at a morning session.

M. A. Arvin of Owensboro was elected president of the Kentucky organization the night before. K. Z. Wilking of Owensboro was elected vice-president to succeed Mr. Arvin. Other officers, all re-elected, were vice-presidents, P. V. Van Gilst of Ashland and M. G. Powers of Huntington, W. Va.; secretary, E. L. McDonald of Lexington; executive secretary-treasurer, J. C. Preston of Owensboro.

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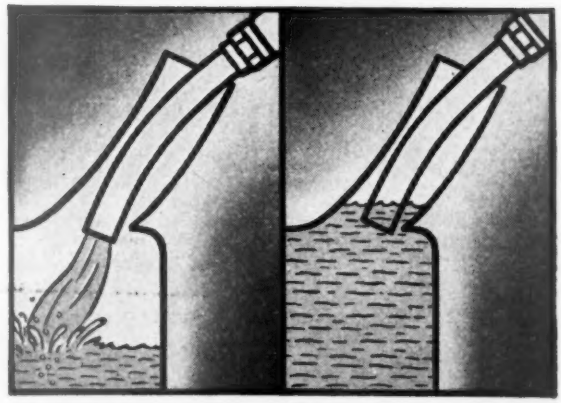

1 When the "Safety-Fill" Nozzle is inserted into the fill pipe and the valve is opened, gas flows, as it does through any other nozzle. But from here on "Safety-Fill" is different...

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Oil Men Square Shoulders To Take New War Load As Fighters' Need for 100-Octane Is Told

NPN News Bureau

WASHINGTON — A large group of men who have been fighting the war of production these many months stepped from a conference room in Washington this week, after having heard high ranking Army and Navy officials appeal for staggering amounts of 100-octane aviation gasoline which must be provided as the only means of carrying the United Nations forces to victory.

These men were all oil executives, presidents or vice-presidents of refineries manufacturing 100-octane.

Their sober, thoughtful expressions testified to their awareness of the tremendous task before them. They had heard an off-the-record discussion. They had been told by high ranking officers that the armed forces must have "more and more aviation gasoline."

William R. Boyd, Jr., chairman of the Petroleum Industry War Council, expressed the determination of the group when he assured PAW Ickes that the oil industry would "make good any check drawn upon it."

"Never Failed To Deliver"

Mr. Ickes, on the other hand, expressed the faith of PAW in the ability of the industry to meet any need. He said:

"The oil industry has never failed to deliver in this war and it will not fail to do even the impossible now—again."

The object of the conference was to give the oil men a complete picture of aviation gasoline requirements, which have shot to unprecedented quotas since the launching of the European invasion.

Deputy PAW Davies pointed out that, while all overseas military requirements for petroleum products have been fully met the United Nations air forces were operating on a schedule which is constantly increasing and is maintained round-the-clock daily.

Army and Navy officials gave the refiners a detailed report of what has happened and what is happening in the various war theaters. Among the officers who detailed the information concerning the war fronts were Gen. H. H. Arnold; Air Marshal Sir William L. Welsh, of the R.A.F.; and Admiral D. C. Ramsey, chief of the Bureau of Naval Aeronautics. All of them urged the refiners to push their plants to the very limit in order to provide "the stuff that powers the attack."

Military Notables Attend

Among Army and Navy officials who attended were Undersecretary of the Navy Ralph Bard, Admiral A. F. Carter, Gen. W. B. Pyron, Admiral W. B. Young, Admiral S. M. Robinson, Admiral J. M. Reeves, Brig. Gen. P. W. Timberlake, deputy chief of Air Staff; Brig. Gen. G. C. Jamison, Army Air Forces; Brig. Gen. J. Y. York, Army Air Forces; Col. D. G. Lingle, Aviation Petroleum Branch; Capt. S. B. Spangler, Bureau of Aeronautics; Lieut. Comm. J. A. Walstrom, Army-Navy Petroleum Board; Lieut. George Ballou, Army-Navy Petroleum Board, and Col. H. W. Howze, Aviation Petroleum Branch.

Wing Commander R. S. Darbishire, R.A.F.; Capt. H. M. Shaffer, Bureau of Supplies and Accounts; M. J. Madigan, War Department; Admiral Ben Moreel, Navy Department; M. J. Deutch, War Production Board; Bradley Haight, War Manpower Commission.

Refiners attending the conference included: Robert Colley, A. P. Frame and W. A. Jones, Atlantic Refining Co.; H. W. Camp, Cities Service Oil Co.; Walter Miller Continental Oil Co.; Hines H. Baker, Humble Oil & Refining Co.; Henry A. Rosenberg, Crown Central Petroleum Co.; K. S. Adams, Phillips Petroleum Co.; H. M. Dawes and C. B. Watson, Pure Oil Co.; Alexander Fraser, Mr. Taylor and Mr. Davis, Shell Oil Company.

W. F. Burt, Socony-Vacuum Oil Co., Inc.; R. G. Follis, Standard Oil Co. of California; G. Paulus, Standard Oil Co. of Indiana; W. T. Holliday, Standard Oil Co. of Ohio; W. T. Kline, M. Halpern, The Texas Co.; Hershel Hyde and Herbert Chase, Tide Water Associated Oil Co.; Paul H. Blazer, Ashland Oil & Refining Co.; H. V. Alspaugh, Associated Refineries, Inc.

Joe N. Champlin, Champlin Refining Co.; H. M. Robineau, Frontier Refining Co.; representatives of General Petroleum Corp. of California; William A. Slater, Gulf Oil & Refining Co.; Mr. Clulow, Shell Oil Co., Inc.; R. B. Kahle, Eastern States Petroleum Co., Inc.; J. W. Newton, Magnolia Petroleum Co., A. L. Marsten, Mohawk Petroleum Corp.; Edwin Singer, Great Southern Corp.

R. E. Wilson and D. J. Smith, Pan American Refining Corp.; W. S. Zehrung, Pennzoil Co.; Sylvester Dayson, Premier Oil Refining Co. of Texas; Walter Duke, Root Petroleum Co.; Clarence Thayer and Dr. John Bates, Sun Oil Co.; J. S. Abercrombie, J. S. Abercrombie Co.; F. W. Abrams and Dr. H. G. Burks, Jr., Standard Oil Co. (N. J.); representatives of the Shell Union Oil Corp.

O. D. Robinson and Harland Castul, Republic Oil Refining Co.; Walter Drake, Northport Petroleum of Delaware; G. L. Stewart, Imperial Oil Co., Ltd.; H. M. Herron and D. J. Hanna, Bahrein Petroleum Co., Ltd.; John Berkin, Asiatic Petroleum Co.; Basil R. Jackson, Anglo-Iranian Oil Co.; a representative of Sinclair Refining Co.

Others attending included: George H. Hill, Jr.; George Stoner, Hans Klagsbrunn and James C. Hobday of Defense Plant Corp.; J. M. Johnson and F. Dow of the Office of Defense Transportation; Charles Rayner of the State Department; H. Wilkinson, S. Leigh and G. S. Dear, British Petroleum representatives; Emory S. Land of the War Shipping Administration; John McClintock of CIAA, and Albert Ernst of the Foreign Economic Administration.

* * *

Allies' Octane Projects 80% Complete, Davies Reports

NPN News Bureau

WASHINGTON — The authorized projects in the 100-octane aviation gasoline program of the United Nations is 80% complete, Deputy PAW Davies announced this week. Mr. Davies said that of the 189 projects involved in the program, 150 had been completed.

Mr. Davies added that seven of the projects were completed in 1942, while 71 were finished in 1943, and 72 were completed this year. And among the remaining units, 25 are expected to be ready this summer, with the balance scheduled for completion during the fall.

The following is a breakdown of the 100-octane program by type of installation (some of the installations include more than one unit of a particular type):

Type of Unit	Completed	Building	Total
Alkylation	56	13	69
Isomerization	26	9	35
Fluid Catalytic Cracking	26	7	33
Thermofor Catalytic Cracking	10	6	16
Houdry Catalytic Cracking	9	1	10
Houdry Catalytic Cracking (revamping)	4	..	4
Hydrogenation	2	2	4
Dehydrogenation	2	..	2
Miscellaneous	15	1	16
	150	39	189

A list of companies which participated in the 100-octane construction program, as well as the plant locations, types of units and completion dates was also made public by Mr. Davies. However, the list does not include units that were already contributing to 100-octane production before the start of the current program. In all, Mr. Davies said, approximately 450 refineries and natural gasoline plants are now engaged in the manufacture of 100-octane or its components. (*List starts on p. 24*)

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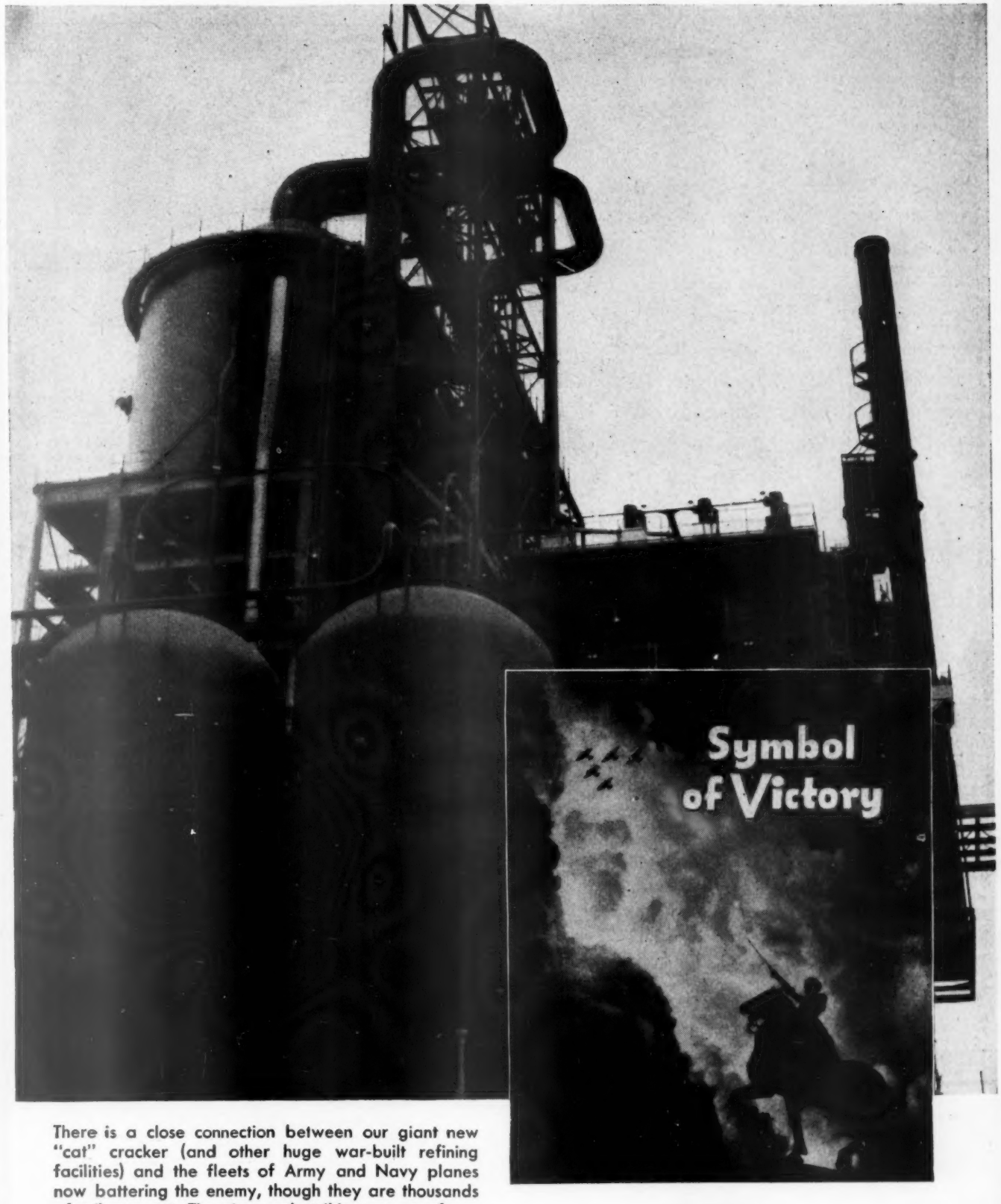
Status of 100-Octane Construction Program

Company	Plant Location	Completed Units — Type	Completed Units — Completion Date	Units Building — Type	Units Building — Scheduled Completion
J. S. Abercrombie-Harrison Oil Co.	Sweeney, Tex.	Crude Topping Unit	Fall, 1943	Isomerization	Summer, 1944
		Thermal Reforming	Fall, 1943		
		Alkylation	Spring, 1944		
		Fluid Catalytic Cracking	Spring, 1944		
Atlantic Refining Co.	Atreco, Tex.	Alkylation	Winter, 1943	Fluid Catalytic Cracking	Summer, 1944
				Alkylation	Summer, 1944
Atlantic Refining Co.	Philadelphia, Pa.	Alkylation	Spring, 1943	Fluid Catalytic Cracking	Summer, 1944
Ashland Refining Co.	Catlettsburg, Ky.	Thermofor Cat. Cracking	Spring, 1944	Alkylation	Summer, 1944
Associated Refineries, Inc.	Duncan, Okla.	Fluid Catalytic Cracking	Spring, 1944		
		Alkylation	Spring, 1944		
		Isomerization	Spring, 1944		
Champlin Refining Co.	Enid, Okla.	Alkylation	Winter, 1943		
		Isomerization	Winter, 1943		
Cities Service Oil Co.	East Chicago, Ill.	Alkylation	Spring, 1943		
		Isomerization	Spring, 1943		
Cities Service Refining Corp.	Lake Charles, La.	Topping Unit No. 1	Fall, 1943	Fluid Cat. Crack. No. 3	Summer, 1944
		Fluid Cat. Crack. No. 1	Winter, 1943	Isomerization	Summer, 1944
		Alkylation No. 1	Spring, 1944		
		Fluid Cat. Crack. No. 2	Spring, 1944		
		Topping Unit No. 2	Spring, 1944		
		Alkylation No. 2	Spring, 1944		
Continental Oil Co.	Ponca City, Okla.	Thermofor Cat. Cracking	Spring, 1944		
		Alkylation	Spring, 1944		
		Isomerization	Spring, 1944		
Continental Oil Co.	Lake Charles, La.	Alkylation	Winter, 1942		
Continental Oil Co.	Wichita Falls, Tex.	Alkylation	Winter, 1942		
Cooperative Refinery Assn.	Coffeyville, Kans.	Fluid Catalytic Cracking	Spring, 1944	Isomerization	Summer, 1944
		Alkylation	Spring, 1944		
Crown Central Petroleum Corp.	Houston, Tex.	Thermofor Cat. Cracking	Spring, 1944	Alkylation	Summer, 1944
				Isomerization	Summer, 1944
Eastern States Petroleum Co., Inc.	Houston, Tex.	Alkylation	Winter, 1943		
		Isomerization	Winter, 1943		
		Fluid Catalytic Cracking	Winter, 1943		
Frontier Refining Co.	Cheyenne, Wyo.	Fluid Catalytic Cracking	Spring, 1944		
		Alkylation	Spring, 1944		
		Isomerization	Spring, 1944		
General Petroleum Co.	Torrance, Calif.	Alkylation	Winter, 1942		
		Thermofor Cat. Cracking	Winter, 1942		
		Thermofor Cat. Cracking	Spring, 1944		
Great Southern Corp.	Corpus Christi, Tex.	Alkylation	Winter, 1943		
		Dehydrogenation	Spring, 1944		
Gulf Oil Corp.	Port Arthur, Tex.	Houdry Cat. Cracking	Spring, 1943		
		Alkylation	Spring, 1943		
		Thermofor Cat. Cracking	Fall, 1943		
Humble Oil & Refining Co.	Baytown, Tex.	Fluid Catalytic Cracking	Winter, 1942	Hydrogenation	Summer, 1944
		Alkylation	Winter, 1942		
		Fluid Catalytic Cracking	Winter, 1943		
Magnolia Petroleum Co.	Beaumont, Tex.	Alkylation	Summer, 1943		
		Houdry Cat. Cracking	Summer, 1943		
		Thermofor Cat. Cracking	Summer, 1943		
Mohawk Petroleum Corp.	Bakersfield, Calif.	Alkylation	Winter, 1943		
		Isomerization	Winter, 1943		
Pan American Refining Corp.	Texas City, Tex.	Fluid Catalytic Cracking	Spring, 1944	Isomerization	Late 1944
		Butylene	Spring, 1944		
Pennzoil Co.	Oil City, Pa.	Fluid Catalytic Cracking	Spring, 1944		
		Alkylation	Spring, 1944		
Phillips Petroleum Co.	Borger, Tex.	Alkylation	Winter, 1942	Catalytic Cracking	Summer, 1944
				Alkylation	Summer, 1944
				Isomerization	Summer, 1944
Phillips Petroleum Co.	Kansas City, Kans.	Alkylation	Summer, 1943		
		Alkylation	Fall, 1943		
		Isomerization	Fall, 1943		
Premier Refining Co.	Cotton Valley, La.	Alkylation	Winter, 1943		
		Dehydrogenation	Spring, 1944		
Pure Oil Co.	Smiths Bluff, Tex.	Alkylation	Fall, 1943		
		Thermofor Cat. Cracking	Winter, 1943		
Richfield Oil Corp.	Watson, Calif.	Alkylation	Winter, 1942		
		Isomerization	Winter, 1942		
Richfield Oil Corp.				Alkylation	Summer, 1944
				Thermofor Cat. Cracking	Summer, 1944
Republic Oil Refining Co.	Texas City, Tex.	Alkylation	Winter, 1943		
		Fluid Catalytic Cracking	Spring, 1944		
Root Petroleum Co.	El Dorado, Ark.	Alkylation	Winter, 1943		
		Isomerization	Winter, 1943		
		Fluid Catalytic Cracking	Winter, 1943		
Shell Oil Co.	Wood River, Ill.	Alkylation	Summer, 1943	Hydrogenation	Summer, 1944
		Fluid Cat. Crack. No. 1	Winter, 1943		
		Fluid Cat. Crack. No. 2	Winter, 1943		
Shell Oil Co.	Wilmington, Calif.	Alkylation	Summer, 1943		
		Isomerization	Summer, 1943		
		Fluid Catalytic Cracking	Fall, 1943		
		Hydrogenation	Spring, 1944		
Shell Oil Co.	Houston, Tex.	Alkylation	Summer, 1943		
		Isomerization	Summer, 1943		
Sinclair Refining Co.	Corpus Christi, Tex.	Houdry Catalytic Crack.	Spring, 1944	Alkylation	Summer, 1944

(*Continued on p. 26*)



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Status of 100-Octane Construction Program (Cont.)

Company	Plant Location	Completed Units — Type	Completed Units — Completion Date	Units Building — Type	Units Building — Scheduled Completion
Sinclair Refining Co.	Sinclair, Wyo.	Alkylation	Winter, 1943		
		Isomerization	Winter, 1943		
		Fluid Catalytic Cracking	Spring, 1944		
Sinclair Refining Co.	Houston, Tex.	Alkylation	Spring, 1943		
		Houdry Cat. Cracking	Spring, 1943		
		Thermofor Cat. Cracking	Spring, 1944		
		Depentanizing Unit	Spring, 1944		
Socony-Vacuum Oil Co.	East St. Louis, Ill.	Alkylation	Spring, 1944		
		Thermofor Cat. Cracking	Spring, 1944		
Socony-Vacuum Oil Co.	East Chicago, Ind.	Houdry Cat. Cracking	Fall, 1942		
Socony-Vacuum Oil Co.	Augusta, Kans.	Alkylation	Summer, 1943		
Socony-Vacuum Oil Co.	Paulsboro, N. J.			Alkylation	Summer, 1944
				Thermofor Cat. Cracking	Summer, 1944
Socony-Vacuum Oil Co.	Buffalo, N. Y.	Houdry Cat. Cracking (Revamping)	Fall, 1943		
Socony-Vacuum Oil Co.	Brooklyn, N. Y.	Houdry Cat. Cracking (Revamping)	Winter, 1942		
Socony-Vacuum Oil Co.	Trenton, Mich.	Houdry Cat. Cracking (Revamping)	Winter, 1942		
Southport Petroleum Co.	Texas City, Tex.	Houdry Cat. Cracking	Winter, 1943		
		Alkylation	Spring, 1944		
Standard Oil Co. of Calif.	El Segundo, Calif.	Houdry Cat. Cracking	Fall, 1942		
		Isomerization	Fall, 1943		
Standard Oil Co. of Calif.	Richmond, Calif.	Thermal Cracking	Summer, 1942	Alkylation	Late 1944
				Thermofor Cat. Cracking	Late 1944
Standard Oil Co. (Ind.)	Whiting, Ind.	Hydroforming	Fall, 1943		
		Naphtha Isomerization	Winter, 1943		
		Alkylation	Winter, 1943		
		Isomerization	Winter, 1943		
		Fractionation	Winter, 1943		
Standard Oil Co. (Ind.)	Wood River, Ill.	Fluid Catalytic Cracking	Winter, 1943		
		Alkylation	Spring, 1944		
		Isomerization	Spring, 1944		
Standard Oil Co. of Louisiana	Baton Rouge, La.	Alkylation	Winter, 1942		
		Fluid Catalytic Cracking	Fall, 1943		
		Blending Agent Unit	Winter, 1943		
		Hydrogenation	Winter, 1943		
Standard Oil Co. of New Jersey	Bayway, N. J.	Fluid Catalytic Cracking	Winter, 1942		
Standard Oil Co. of New Jersey	Baltimore, Md.	Alkylation	Winter, 1942		
		Fluid Catalytic Cracking	Winter, 1943		
Standard Oil Co. (Ohio)	Cleveland, Ohio	Houdry Cat. Cracking	Spring, 1944		
Standard Oil Co. (Ohio)	Toledo, Ohio	Alkylation	Summer, 1943		
Sun Oil Co.	Marcus Hook, Pa.	Alkylation	Summer, 1943	Thermofor Cat. Cracking	Late 1944
		Houdry Cat. Cracking	Summer, 1943		
The Texas Co.	Port Arthur, Tex.	Isomerization, Alkylation	Spring, 1943		
		Alkylation	Fall, 1943		
		Fluid Cat. Crack. No. 1	Winter, 1943		
		Fluid Cat. Crack. No. 2	Spring, 1944		
The Texas Co.	Lockport, Ill.	Alkylation	Spring, 1943		
		Isomerization	Spring, 1943		
		Hydroforming	Spring, 1943		
The Texas Co.	Wilmington, Calif.	Alkylation	Spring, 1944	Fluid Catalytic Cracking	Summer, 1944
Tidewater Associated Oil Co.	Avon, Calif.	Alkylation	Summer, 1943	Isomerization	Summer, 1944
		Isomerization	Summer, 1943		
		Alkylation	Winter, 1943	Fluid Catalytic Cracking	Late 1944
		Isomerization	Winter, 1943		
Tidewater Associated Oil Co.	Bayonne, N. J.	Houdry Cat. Cracking (Revamping)	Winter, 1943	Thermofor Cat. Cracking	Late 1944
Union Oil Co.	Wilmington, Calif.	Thermal Reforming	Spring, 1943	Thermofor Cat. Cracking	Late 1944
		Thermal Cracking	Winter, 1943		
		Alkylation	Spring, 1944		
		Isomerization	Spring, 1944		
Utah Oil Refining Co.	Salt Lake City, Utah	Fluid Catalytic Cracking	Spring, 1943		
		Alkylation	Spring, 1943		
		Isomerization	Spring, 1943		
		Naphtha Isomerization	Spring, 1943		
Wilshire Oil Co.	Norwalk, Calif.	Alkylation	Winter, 1943		
		Isomerization	Winter, 1943		
		Fluid Catalytic Cracking	Winter, 1943		

Foreign Units

Anglo-Iranian Oil Co.	Abadan, Persia	Alkylation	Fall, 1943	Alkylation	Summer, 1944
		Superfractionation	Fall, 1943	Superfractionation	Summer, 1944
				Alkylation	Late 1944
				Isomerization	Late 1944
Asiatic Petroleum Corp.	Curacao, N.W.I.	Cumene	Winter, 1943		
		Alkylation	Spring, 1944		
		Isomerization	Spring, 1944		
Bahrein Petroleum Co.	Bahrein Island			Fluid Catalytic Cracking	Late 1944
				Alkylation	Late 1944
				Isomerization	Late 1944
Imperial Oil Co., Ltd.	Calgary, Alta., Canada	Alkylation	Spring, 1943		
Lago Oil & Transport Co., Ltd.	Aruba, N.W.I.	Alkylation	Fall, 1943		
		Fluid Catalytic Cracking	Winter, 1943		
Shell Oil Co.	Montreal, Canada			Alkylation	Summer, 1944
USSR	Russia			Houdry Cat. Cracking	Late 1944
				Alkylation	Late 1944

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For years, many oil jobbers and compounders have relied exclusively on the services and uniformly high quality of these lubricating oils...produced from selected Mid-Continent 100% paraffin base crudes. Let us quote you.

Send for Prices and Specifications

. . . on any of these or other types of lubricants especially adapted to your needs

Aviation Oils **Heavy Duty Engine Oils** **Diesel Engine Oils**
Solvent Bright Stocks **Solvent Neutrals**
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MID-CONTINENT PETROLEUM CORPORATION
TULSA, OKLAHOMA
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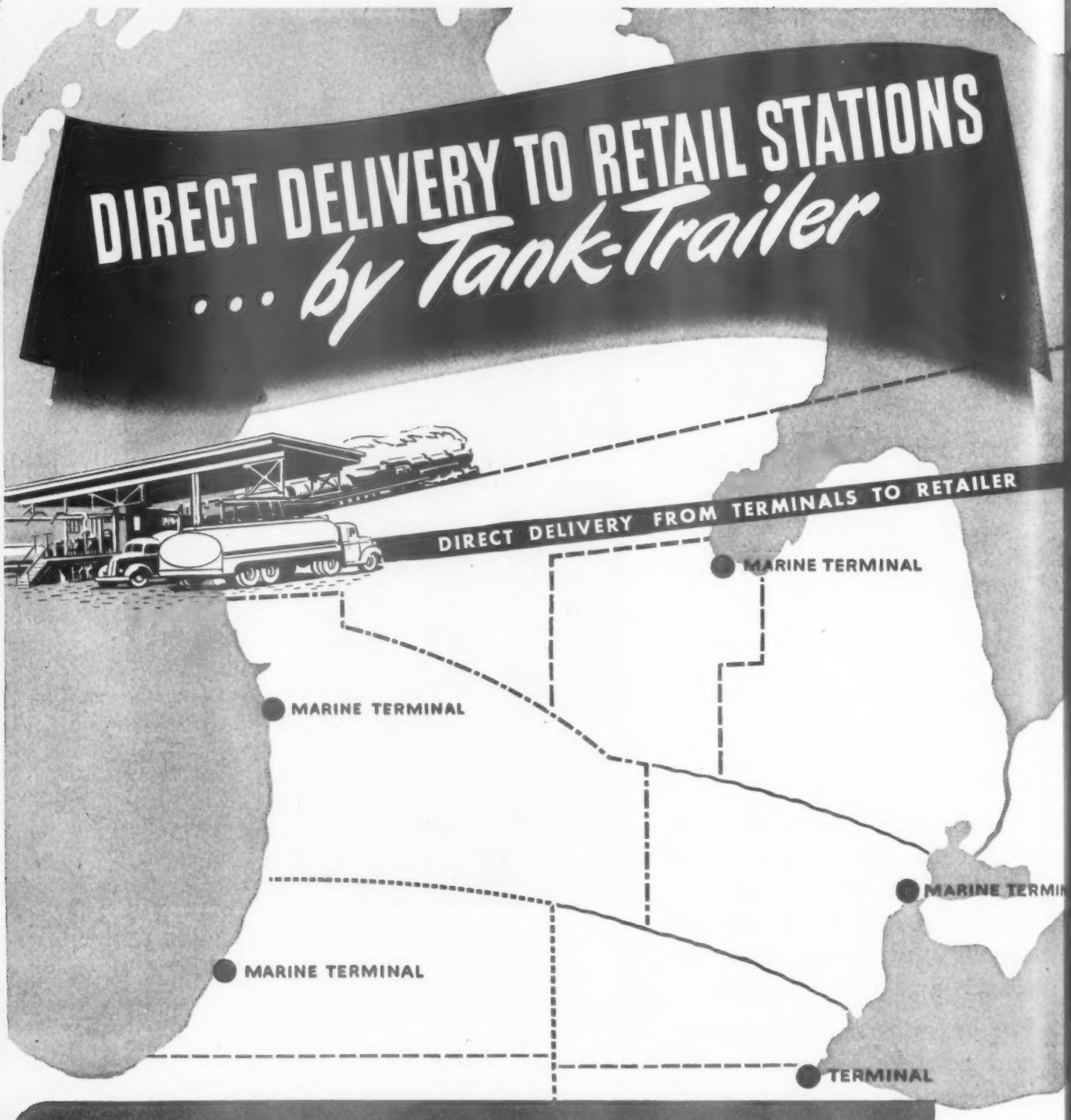
DIAMOND 760 MOTOR OIL

Refiners and Marketers of the Famous Line of DIAMOND D-X Petroleum Products and Specialties

DIRECT DELIVERY TO RETAIL STATIONS ... by Tank-Trailer

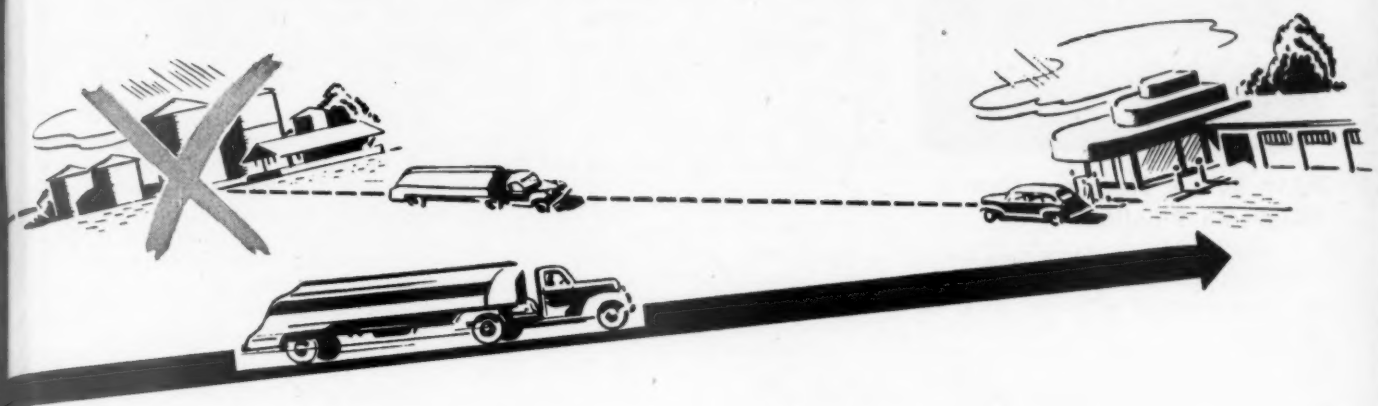


*Comparative Summary of Operating Figures for 1938 and 1943

	1938	1943
Number of motor vehicles	58	25
Number of tank-trailers	0	14
Number of bulk stations	33	21
Average capacity per vehicle (gallons)	1081	3120
Miles traveled annually (thousands)	777	632
Number of deliveries	102,429	35,866
Gallons delivered (thousands)	34,334	67,683
Average delivery per stop per station	335	1855

MORE FRUEHAUF TANK-TRAILERS ON TH

How One Major Oil Company Eliminated 12 Bulk Stations . . . Handles Double the Gallonage with Half as Many Trucks . . . Increased Average "Dump" Per Station Over 400%



IN 1938 the Detroit division of one of the major oil companies had 58 tank-trucks . . . but no Tank-Trailers. Gasoline was shipped by rail from pipe-line and marine terminals to bulk depots, and then distributed by truck to local service stations.

Today this division operates with only 25 motor vehicles . . . plus 14 Tank-Trailers. Shipment by rail has been entirely eliminated, releasing the tank cars for the long eastern haul.

The big Tank-Trailers . . . five 2-trailer "trains" with 8,000 gallons capacity and four 3,600-gallon Semi-Trailers . . . deliver gasoline directly from terminals at Toledo, Detroit, Bay City, St. Joseph and Grand Haven to retail stations in the surrounding areas.

The economy and efficiency of the Tank-Trailer method are strikingly shown by a comparison of 1943 operating figures with those of 1938*. Note, particularly, that with less than half as many power units, the gallonage handled was almost doubled . . . yet there was a reduction in mileage of 145,000 miles—a big saving in rubber and gasoline. And a similar saving in steel. An announcement by the War Production Board said, "Tank-Trailers . . . transport more oil per pound of steel and rubber and require less manpower than any other type of vehicle available for general use."

Not only are Tank-Trailers most efficient per pound of critical materials . . . they are the most flexible means of oil transportation—able to move into any territory, on schedules to meet emergency conditions as well as regular deliveries.

A Tank-Trailer is ready to leave the minute it is loaded. There's no waiting for a locomotive, or for other cars to be loaded, or for a time schedule. On many hauls, one Tank-Trailer delivers several times the gallonage that one tank car can deliver . . . because, of course, the Trailer works continuously and makes more round trips. Actual records show that one Tank-Trailer is often the equivalent of 11 tank cars!

Tank-Trailers for essential civilian use are now being built under the civilian production program. But production is limited, so if you are planning the purchase of a new Tank-Trailer, you should file application form WPB-663 immediately. Your local Fruehauf Branch will gladly assist you.

World's Largest Builders of Truck-Trailers **FRUEHAUF TRAILER COMPANY • DETROIT** *Service in Principal Cities*

Fruehauf TRAILERS

"ENGINEERED TRANSPORTATION"– Reg. U. S. Pat. Off.

TH OAD THAN ANY OTHER MAKE . . . . .

PAW Denies Pleas for New Oklahoma Pipelines

NPN News Bureau

CHICAGO—All requests for permits for construction of additional crude oil pipelines from the West Edmond field in Oklahoma are being denied by PAW Dist. 2 Director Vandeveer, who reviewed applications previously turned down by Washington.

Present facilities of Cimarron Pipe Line Co. are sufficient to handle production and will be for some time, PAW Vandeveer said, adding that it is not essential for Cimarron to become a common carrier.

Further details: Interstate Commerce Commission and Justice Department have adopted policy that private carrier transporting oil for other shippers at request of governmental agency did not prejudice its status as private carrier. Pipeline rates are a subject outside of PAW's province.

Cimarron Pipeline Co. was requested to make whatever changes are necessary to move the oil and to work out agreements with shippers. Champlin Refining Co., subsidiary of Cimarron Pipeline, under the pipeline company's agreement, is to obtain what crude the refinery requires from the field by direct purchase or exchange. (*See NPN, May* 31, *p.* 13).

Use of High-Grade Oil Imperative for Control Of Sludge, S.A.E. Told at Philadelphia

Special to NPN

PHILADELPHIA — Most important method of controlling hot engine sludge is the use of a high-quality heavy-duty-type lubricating oil, according to a report presented by H. C. Mougey, Technical Director, Research Laboratories Division, General Motors Corp., before the Society of Automotive Engineers National Transportation and Maintenance Meeting here June 28 and 29.

Also speaking on sludge control were B. E. Sibley of Continental Oil Co., Ponca City, Okla., and Earl G. Gunn of Fram Corp., East Providence, R. I. Other topics at the two-day session were synthetic rubber tires, use of electronics in vulcanizing tires, care of cooling systems, and practical postwar motor truck design.

Three other general methods were recommended by Mr. Mougey for controlling hot engine sludge, in addition to using a high quality oil: (1) application of oil filters, (2) adequate temperature control, and (3) frequent crankcase drainings.

"Regardless of what is done by any or all of these three methods," Mr. Mougey stated, "the car owner or operator who is trying to control hot engine sludge should use high quality oil. This means heavy-duty oil in commercial engines, and in the postwar period I believe it will also mean use of heavy duty oils in passenger cars."

Mr. Mougey described heavy-duty oils as those which are resistant to the development of acid or sludge, or both, and which leave a commercially clean engine when drained. The additives in these oils are both oxidation inhibitors and detergents.

Under present WPB regulations, oils of this type are reserved for the military forces and commercial operators. "Until such oils again become available for passenger cars," Mr. Mougey continued, "use an oil which is as resistant to oxidation as is possible under present war restrictions."

Explaining the other methods of hot engine sludge control, Mr. Mougey suggested that operators try to remove sludge from oil as fast as it forms by some suitable means, such as filters. Temperature control, he also pointed out, prevents excessive heat from causing oil oxidation and sludge formation, without allowing engine temperature to fall so low as to form low-heat sludge.

Crankcases should be drained with sufficient frequency to prevent sludge accumulations from becoming too large, and draining periods must be determined by use rather than by time or mileage, Mr. Mougey said. "With lower quality oils and with more severe operating conditions the drain periods should be shorter.

Speaking on "Cold Engine Sludge and Its Control," Mr. Sibley cited the results of a survey of 37 commercial motor vehicle fleets operating more than 37,000 vehicles. He said that experience had shown that improvements in reducing sludge formation were obtained by using lubricating oils of the detergent type, although he warned that use of such oils is in itself no panacea.

Three Main Points

Mr. Sibley recommended improved engine design to aid in controlling sludge formation by facilitating the cleaning of oil passage ways and by assuring complete crankcase draining.

Three main points concerning the use of filters were brought out by Mr. Gunn:

"1. Abrasives should be filtered out as quickly as possible. This means a high, clean oil flow rate.

"2. Resins are thrown out of solution by the addition of new oil, by water, or by dilution, and in this form can readily be filtered out.

"3. Filters not containing activated material remove additives only as they remove solids to which additives are adhering."

Filters of minimum size and designed for a long life, Mr. Gunn asserted, will keep the oil clean under normal conditions for which they are recommended, but will not remove undissolved material rapidly enough. "The obvious remedy," he said, "is to increase filter size and cleaning rate."

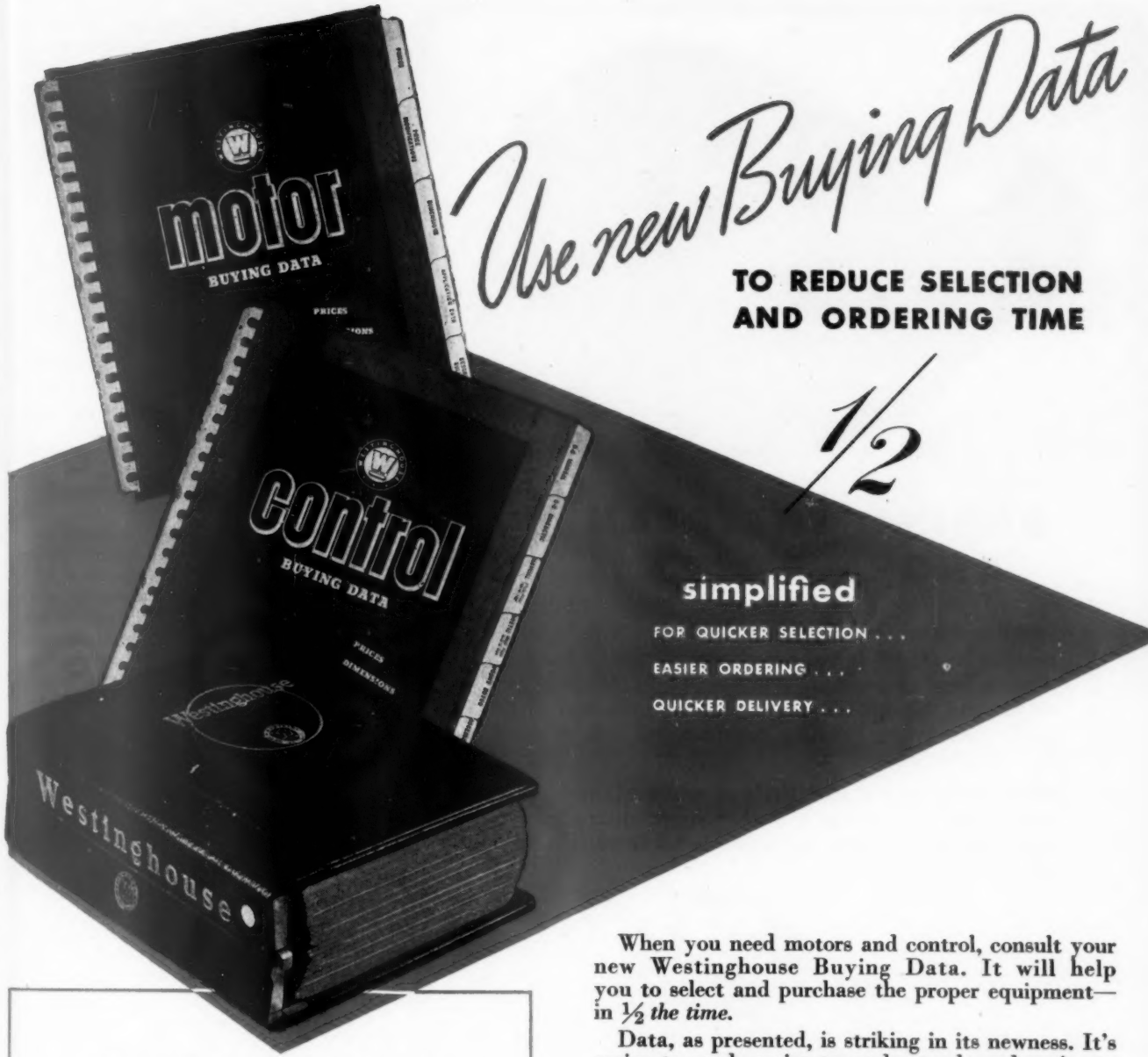
The second session of the conference was told by J. E. Hale of the Firestone Tire & Rubber Co. that war exigencies are creating a huge postwar manufacturing capacity which will probably produce synthetic tires low in price, ade-

East Coast Tank Car Hauls Decline 25,383 b/d

NPN News Bureau

WASHINGTON—Tank car hauls of crude products to the East Coast averaged 690,048 b/d during the week ended June 24, compared with 715,431 b/d the previous week. Oil companies loaded 22,358 tank cars as follows:

Abercrombie Oil	258	Drake	7	Pure	45
Aetna	7	Elk Refining	45	Republic	101
Allied	78	Freedom Oil	2	Richfield	168
American Bitumuls	14	Grain League Fed.	4	Rock Island	4
Amsco	168	Globe	223	Roosevelt Oil	3
Anchor	3	Gulf	2039	Royal Petroleum	29
Arkansas Fuel	3	Hartol	51	Shell	682
Ashland Refining	129	Hess, Inc.	5	Sinclair	605
Asiatic Petroleum	23	Home Oil	2	Socony-Vacuum	2998
Atlantic Refining	1377	Hutex	11	Southland	4
Aurora	17	Jenny Mnfg Co.	25	S. O. California	5
James B. Berry Sons	1	Johnson	16	S. O. Indiana	408
Canfield	1	Libby	2	S. O. Kentucky	52
Cantelou	13	Mid-Continent	31	S. O. New Jersey	4682
Canton	12	Mid-West	35	S. O. Ohio	209
Chalmette	18	National Refining	10	Sun	2414
Cities Service	133	Ohio Oil	59	Talco	71
Coastal	54	Pacific	93	Taylor Refining	51
Continental	215	Pan American	1359	Texaco	1912
Cooperative Refining	12	Pana	5	Tide Water	850
Cosco	14	Petroleum Heat & Power	31	Triangle	32
Daugherty	22	Phillips	292	United	1
Deblois	27	Primrose	19	White Fuel	31
Derby Oil	24			Worth	10



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"Control Buying Data" listing a wide variety of controllers and accessories for direct current, single-phase, squirrel-cage, wound rotor motors.

J-90499

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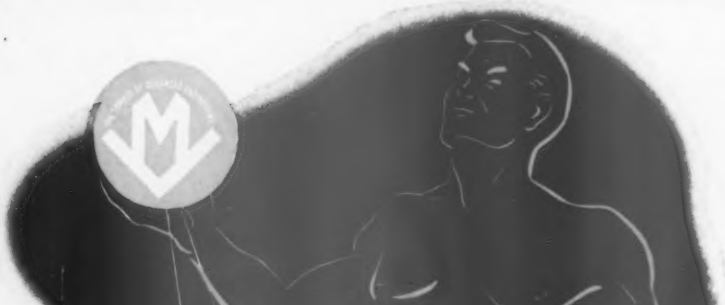
If you are a buyer of Motors and Control, chances are you have already received this new data by mail.

However, if you have not received your copy, write, wire or phone your nearest Westinghouse district office (requests will be filled through district offices only—no mailings from Westinghouse Headquarters at East Pittsburgh). Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Westinghouse MOTORS AND CONTROL

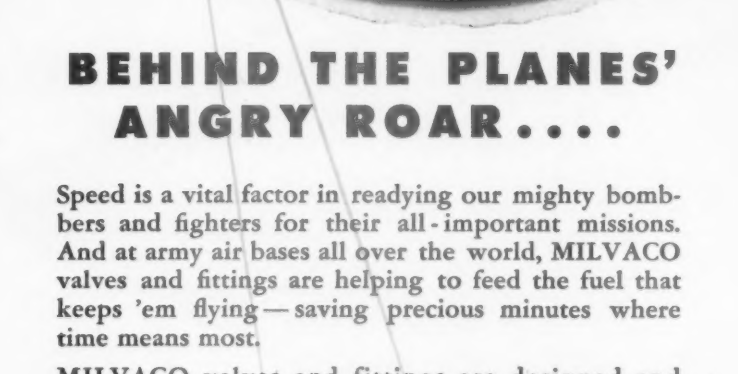
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE



BEHIND THE PLANES' ANGRY ROAR....

Speed is a vital factor in readying our mighty bombbers and fighters for their all-important missions. And at army air bases all over the world, MILVACO valves and fittings are helping to feed the fuel that keeps 'em flying—saving precious minutes where time means most.

MILVACO valves and fittings are designed and engineered to provide a higher speed discharge in refueling operations—to maintain a smooth, constant, full and faster flow.



And this same precision workmanship, accuracy and unfailing dependability, now serving so many military uses, are embodied in MILVACO'S regular line of commercial valves and fittings for the petroleum industry which are now being produced for your more urgent needs.

MILWAUKEE VALVE CO.
MILWAUKEE, WISCONSIN

MILWAUKEE VALVE CO.

quate in quantity, and superior in quality. Mr. Hale predicted that the growing tire shortage would be offset, so far as commercial vehicle needs are concerned, by rising production of increasingly satisfactory synthetic tires. These, he said, would give good service but would also demand better care, curtailed operating speeds in warm weather, and reduced loads.

Predicts New Synthetics

Economic, technical and political factors will affect postwar tire developments, Mr. Hale said, but he expressed the belief that chemistry and engineering will develop the use of synthetics and new varieties of more suitable synthetics. He added that, given two to four years and an opportunity to exploit technical developments, "we will be able to produce tires of even better qualities and characteristics than we have been able to make with synthetic rubber."

The same session heard Lieut. Col. C. W. Vogt, head of the Technical Staff for Supply, U. S. Army Transportation Corps, announce the development of a tire-vulcanizing device employing electronic principles, which will enable major tire repairs to be made in 10 minutes in combat zones and which may become a factor in extending the service life of postwar tires to 100,000 miles.

Col. Vogt described the 500-pound mobile military unit, designed to make repairs at any time and to replace Army tire-repair equipment weighing tons and taking hours to operate. The new device was invented by Col. Vogt and Eino Lasko in the Forest Products Laboratory at Madison, Wis.

It consists of a press ram equipped with an electrode coupled to a high-frequency generator, and a press frame. It applies "internal heat" to make spot and sectional repairs within minutes. The ram and frame, fitted with filler bags which adjust themselves under pressure to tire contours, eliminate the necessity of using molds, can make repairs to tires of any size, and eliminate vulcanizing hazards, such as destructive over-heating of adjacent sections.

The meeting, one of 10 wartime technical conferences being held by the automotive engineers, was sponsored by the society's Transportation and Maintenance Engineering Activity with the cooperation of its Philadelphia section. Gavin W. Laurie of the Atlantic Refining Co. was general chairman.

A.A.A. Finds Growing Crisis Appears in Auto Repair

NPN News Bureau

CLEVELAND—Shortages in automotive maintenance facilities constitute one of the gravest problems now facing home front transportation, according to a survey recently completed by the American Automobile Assn.

Three types of shortages contributing to the present serious situation were pointed out—functional automotive parts, manpower, and garage equipment.

Commenting on the lack of parts,

A.A.A. President Thomas P. Henry said that a recent one-day survey in 15 states disclosed a very substantial number of cars awaiting repairs because of parts shortages. These automobiles had been laid up for periods ranging from one day to nine months.

"The average delay," he continued, "was 22 days per car. And it was noted that 70% had the 'B' or 'C' stickers given occupational users."

Of the manpower shortage, it was said that today there are 20% fewer establishments to do the job, and that those left operating have about half the number of mechanics they employed in 1941.

As a result, A.A.A. recommended that WPB speed up parts manufacture by allocating immediately the necessary material and assigning this production a higher priority. A.A.A. also suggested release of materials needed for producing automotive shop equipment, now being rapidly worn out, and that WMC plan for providing at least 100,000 automotive mechanics to meet minimum repair needs.

Road Building Declines Sharply in Illinois

Special to NPN

SPRINGFIELD, ILL.—The *Highway Bulletin* for May and June of the Division of Highways of Illinois reports that contracts for state highway construction awarded during 1942 were 12% less and those awarded during 1943 were 44% less than the annual average for the 20 years preceding the war. Military access roads and strategic highways have accounted for more than 40% of the contracts awarded in these two years.

Relaxation of legal load limits on trucks at the outset of the war promised certain deterioration of pavements which would speed their ultimate failure, the bulletin explains. Ordinary maintenance methods were not deemed sufficient to cope with the situation but even a partial breakdown of the State's highway transportation system would disrupt civilian activities and seriously impede the movement of vital war goods.

To prevent this an intensive program of pavement rehabilitation, by contract, was adopted as the most effective solution to the problem. Two general types of treatment were undertaken: bituminous surfacing of existing rigid-type pavements which had become cracked and rough but which still had sufficient structural strength to serve as satisfactory bases and the patching and repair of existing concrete pavements on which deterioration had progressed too far to be arrested by resurfacing.

Since the program was inaugurated late in 1940, bituminous surfaces have been added to 330 miles of pavement. Over 1,450,000 square yards of pavement have been patched and repaired. It is expected that an additional 165 miles of bituminous surfacing and 100,000 square yards of pavement patching will be completed during 1944.

SEND FOR BULLETIN H-52
IT GIVES FULL DETAILS

This Newly Improved

OCECO MANHEAD

is Easy to Operate—Non-Sparking—Positively Gas-Tight Closing, and Easily Welded, or Bolted, to the Tank Roof

● Good gas-tight tanks are expensive, and their contents even more so. But tanks are not tight, nor their contents safe, unless the manheads are designed and built to maintain gas-tightness. Specify Oceco Manheads. They have been tested and approved by Underwriters Laboratories, Inc.

Covers of Oceco Manheads are supported loosely from a sturdy malleable iron yoke,—and are provided with a non-sparking composition or white metal ring, set in the cover, that seats tightly against the narrow seating edge of the body. When the cover is closed and the handwheel tightened, pressure is applied through the yoke to the center of the cover and distributed uniformly around the entire seating surface, assuring positive, gas-tight closure,—preventing the loss of any volatiles through the manhead, and the resulting fire hazard. Oceco Manheads are furnished with steel plate flanged bases (ideal for welding to the tank) or drilled for bolting to the tank roof. Standard or "self-closing" construction. Prices and more complete engineering description on request. Send for Bulletin H-52.

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Division of
THE JOHNSTON & JENNINGS COMPANY
883 Addison Road · Cleveland, Ohio
Engineering and Sales Representatives in the Principal Cities

FIRE PREVENTION AND VAPOR CONSERVATION EQUIPMENT
FOR VOLATILE LIQUID STORAGE TANKS

Case History No. 888

ONLY M. W. KELLOGG SERVICE *Has Them All* ★

Entire 100-Octane Lake Charles colossus designed and built for Cities Service by M. W. Kellogg!

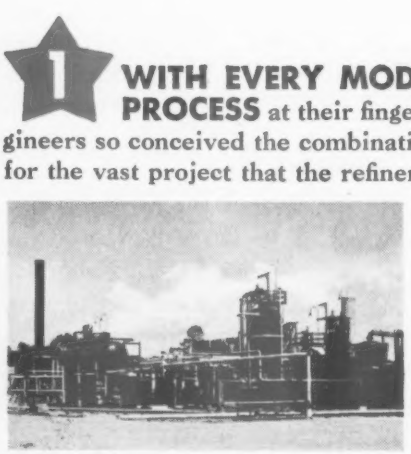
★Only Kellogg Service Has Them All

1. **PROCESS ENGINEERS**—Specialists who have continuously made major contributions to oil refining development, for more than 20 years . . . currently exemplified by their work on fluid catalytic-cracking.
2. **LABORATORIES**—fully equipped and staffed—devoted exclusively to chemical engineering and process development.

   24-HOUR-A-DAY PILOT PLANTS—17 refining processes operating continuously—providing accurate data for commercial scale application.
3. **EXCLUSIVE CHEMICAL ENGINEERING DATA**—Continuously compiled . . . embracing both pilot plant runs and the operation of Kellogg-built refineries. Data extends from beginning of modern refining.
4. **MECHANICAL ENGINEERS**—Kellogg installations—worth hundreds of millions—are their best reference.

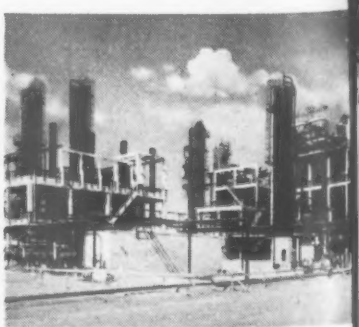
   METALLURGICAL LABORATORY—Establishes continuous check of specifications . . . creates new techniques for the fabrication of refining equipment.
5. **PERMANENT CONSTRUCTION CREWS**—Geared to function all over the world on single units or multiphase refineries . . . team-experience cuts costs, speeds construction.
6. **OPERATING STAFFS**—Specialists at placing new units "on stream"... training of refiner's own operating crews.
7. **LICENSING SERVICE**—Licenses available through Kellogg as Licensor or licensing agent for all types of refining processes.

1 WITH EVERY MODERN REFINING PROCESS at their finger tips . . . Kellogg process engineers so conceived the combination and arrangement of units for the vast project that the refinery—as designed—is producing aviation gasoline with *two-and-a-half times* the efficiency of the industry at large. Simultaneously the second major requirement of the project is being more than realized—for the butylene produced will add over one hundred million pounds of rubber annually—10% of the nation's supply!



Propane treating unit—simultaneously removes asphalt and salt from reduced crude.

2 THE EFFICIENCY of the full-scale refinery is its own measure of the accuracy of data yielded by Kellogg laboratory and pilot plants. The yield from each interrelated processing step was pre-determined with such uncanny accuracy that all commercial units function with optimum results both individually and *collectively*.

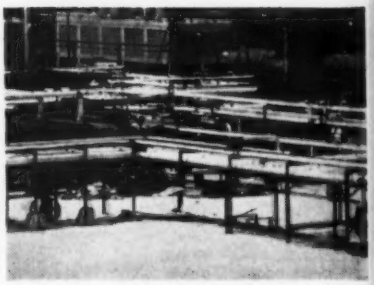


Gas recovery system was designed from mass spectrometer studies.

3 **EXCLUSIVE CHEMICAL ENGINEERING DATA** continuously compiled over the years by The M. W. Kellogg Company proved its full value in the successful development of Cities' project. Based on this data and Kellogg's development of *Fluid* catalytic-cracking . . . the "Cat-Crackers" in this refinery were designed *before* a single such Fluid unit was in operation!

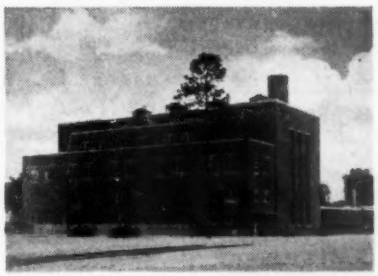
Battery of 3 Fluid "Cats" makes extremely high production possible.

4 **COMPRESSED** into a six months' period . . . this engineering job for Cities is the only one of its size ever undertaken in the history of refining. Over 500,000 man-hours of mechanical engineering were put into the project by the Kellogg staff. The blue-prints alone can be measured by the acre. And the responsibility to Cities for delivering a refinery producing to "specs" was Kellogg's alone.



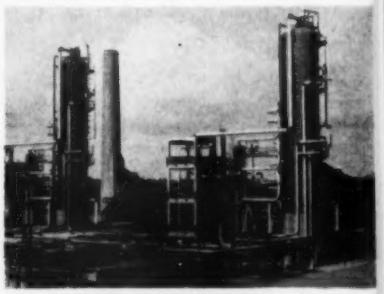
Intricate piping specifications were accurately established by exclusive stress measuring device.

5 **CONSTRUCTION-WISE,** more refining records were set. Better than 25,000,000 man-hours were expended and at peak of the work, M. W. Kellogg's permanent construction crew supervised 11,000 workmen on the job. Working against time and the infinite complications brought about by the war . . . the crew built and linked *thirteen* different major refining units – requiring 50 miles of continuous welding; 1,100 miles of pipe and tubing; a power plant big enough to supply a city of 250,000 people with electricity!



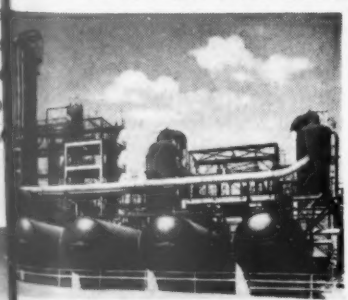
Power house, railroad spurs, docking facilities are but a few of the supplementary projects completed.

6 **ANOTHER REASON** why Kellogg-completed plants operate as designed can be found in the work done by the Kellogg initial operations staff on the Cities' project. These men, with broad experience in all phases of modern refining, assisted the refinery's permanent staff to start up each unit as it was completed. And each unit operates successfully *—as specified.*



Twin Topping Units—two of 13 major units to be put on stream.

7 **THE ALL-IMPORTANT PROTECTION** of the client's interests in the process rights is always part and parcel of M. W. Kellogg operations. Licenses for all major refining processes embodied in the Lake Charles refinery were arranged by Kellogg.



Modern Alkylation units utilize both butenes and pentenes.

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KELLOGG

F. D. R. Gives Go Sign on Navy's Elk Hills Oil; California Standard Plans 65,000 b/d Output

NPN News Bureau

WASHINGTON—The Navy Department this week announced that President Roosevelt has approved agreements under which production from Elk Hills Naval Petroleum Reserve will be stepped up from 15,000 b/d to 65,000 b/d to meet the rapidly expanding oil needs in the Pacific war theatre.

The two agreements, both of which are with California Standard, were, immediately following the President's approval, executed by Navy Secretary Forrestal under authority of legislation recently passed by Congress. The Navy Department said the agreements themselves "have been found by the attorney general to be fully authorized by the new law."

Two agreements approved by the President were (1) unit contract under which California Standard surrenders control of its lands in Elk Hills to the Navy but is permitted to produce and retain 15,000 b/d for refining into war products, and (2) an operating agreement under which the oil company undertakes, "at absolute field cost," to provide extra production of Navy oil which will be sold to the highest qualified bidder for preparation for war use.

At the same time, the Navy announced that an intensive drilling program would be started at Elk Hills and that some 300 wells would be added as soon as possible to the 234 wells already producing there. The Navy has received word from California Standard's San Francisco headquarters that about 12 strings of tools will be moved immediately to Elk Hills and that further drilling will be carried forward as fast as additional materials and crews become available.

30,000,000 Bbls. Authorized

Under joint resolution of Congress and approved by President Roosevelt on June 17, a total of 30,000,000 bbls. of crude are authorized to be produced from the reserve during the next 18 months. Present 15,000 b/d production rate will be upped to 65,000 b/d.

The Navy Department in its announcement of the President's approval of agreements with California Standard, commented further as follows:

"The program carries out the principles of the late Secretary of the Navy, Col. Frank Knox, who recognized the basic advantages of a unit operation and who recommended this plan to Congress. Conservation in the ground of naval reserve oil remains the Navy's fixed policy in so far as war needs will permit.

"The new statute was worked out in co-operation with Chairman Carl Vinson and Chairman David Walsh, and other members of the House and Senate Naval Affairs Committees. Standard of California co-operated fully with the Navy Department throughout long and painstaking negotiations which were concluded under the direction of the undersecretary, the Hon. Ralph A. Bard. The company is now making available for the war effort, without profit to itself, skilled manpower and materials which otherwise could be utilized in carrying on its own business.

Greenman in Charge

"Operations at Elk Hills will be under the direct supervision of the Navy's Office of Naval Petroleum Reserves, the director of which is Capt. William G. Greenman, U. S. N., a regular Navy officer and a former inspector of naval petroleum reserves in California.

"As director, Capt. Greenman succeeds Rear Admiral H. A. Stuart who has retired after a distinguished career during which the reserves were carefully guarded for ultimate war utilization. Admiral Stuart also assisted in laying the groundwork for the present arrangements with Standard.

"The increased production will be obtained wholly from the shallow oil zone, since the types of crudes therefrom are extremely high in both active and lubricating qualities. The shallow oil zone is divided into the first and second sub-scalez zones and the mulinia and sub-mulinia zones.

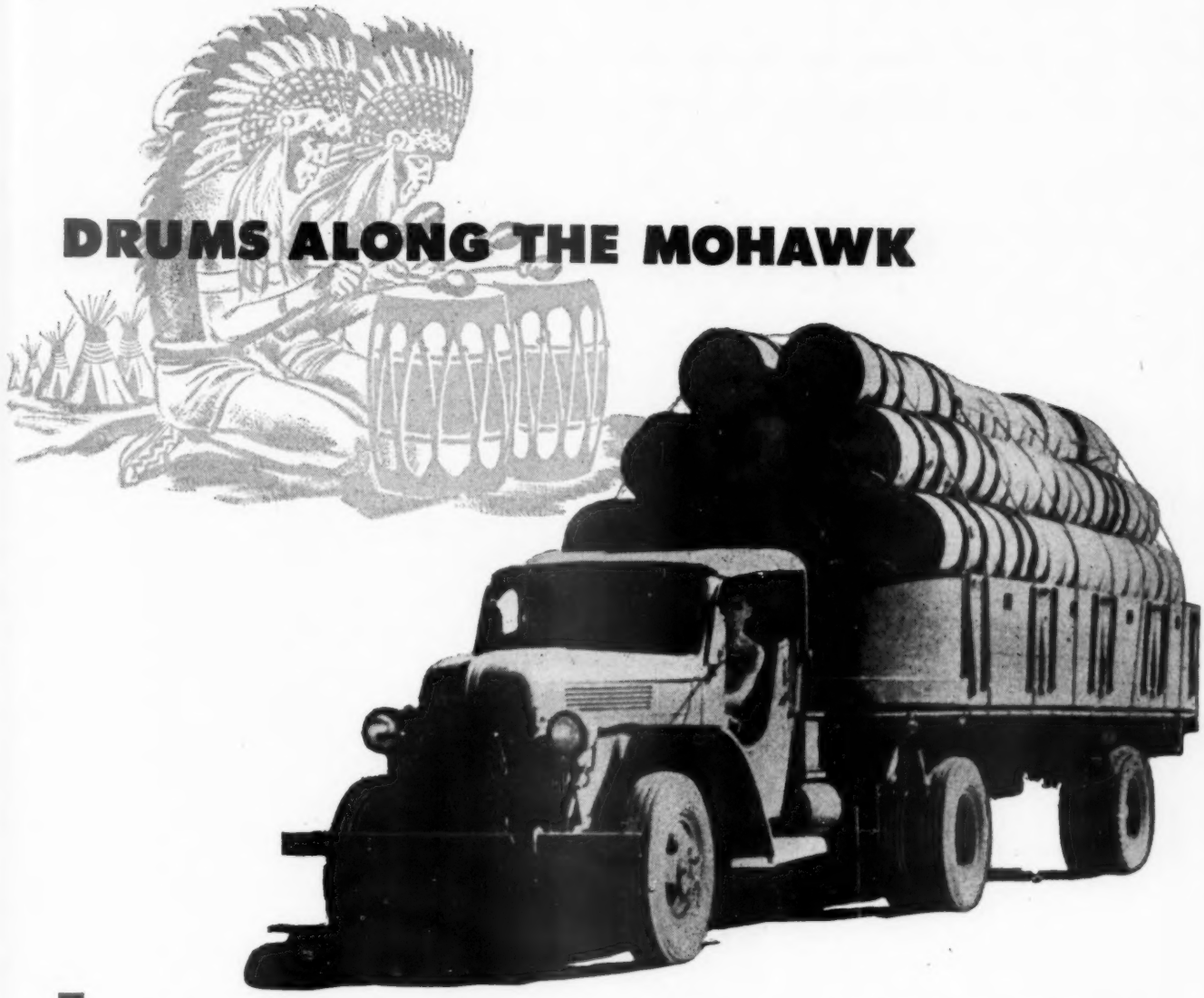
"The average depth of the proposed new wells will approximate 3000 feet. Surface spacing will be one well per 10 acres, but since a differentiation will be made in the sands from which the wells are to be completed, subsurface spacing will be one well per 20 acres.

"The oil sands in the scalez zone have characteristics which indicate that recoveries of oil in place per acre-foot of sand should be as high as any other field in California. The oil in place in the scalez sand is estimated to be over 1500 barrels, per acre foot. By developing and withdrawing oil uniformly over the field and by utilizing the most advanced primary and secondary recovery methods, it is hoped that the greatest possible ultimate recovery of the oil in place will be obtained."

World War I Vet Has Reunion With Fighting Sons

A recent business trip to New York became an occasion for a reunion of C. H. Cutlip, purchasing agent for the Parkersburg Rig and Reel Co., Parkersburg, W. Va., with his two sons, both service men. The photograph was made at the headquarters of the North Sea Mine Force Assn., of which Mr. Cutlip is a member. At the left is Private First Class Claude R. Cutlip, U. S. Army, who came to New York on furlough and at the right, Private First Class Joseph H. Cutlip, U. S. Marine Corps, who just returned from a year's active service in the Pacific. The elder Mr. Cutlip is himself a veteran of the last war, having served at the assembly base at Inverness, Scotland, aboard the U. S. S. Black Hawk. The association is composed of men of the U. S. Navy who transported, assembled, planted and swept mines in the North Sea in 1918 and 1919

DRUMS ALONG THE MOHAWK



Through regions that once resounded with the war drums of the "first Americans", move the war drums of today. They are silent drums. Yet within them is power that can be heard on every continent, and their signal to the world is the roar of planes and the thunder of tanks.

America guards her war drums well. They are made of steel, to give them strength. And to preserve their contents — to prevent seepage and spoilage — they are *hermetically sealed.*

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CLOSURES

Profile in Oil

Take Back Men in U. S. Service, Foulds Cautions Industry

That's One Way to Assure Free Enterprise, Ex-Fuel Oil Chief Says

NPN News Bureau

NEW YORK—If the petroleum industry wishes to relinquish current government controls when the war is over, it must absorb into private jobs its personnel who have entered government service during the last two and one-half years, in the opinion of Ned F. Foulds, who resigned from PAW in April to become vice president and general manager of the Industrial Oil & Gas Co.

Mr. Foulds, who joined PAW in August, 1941, was chief of the Fuel Oils Section in Washington, New York and Chicago. He said that he is glad to be back in private industry, although he has no regrets at spending almost three years with the government. "I wouldn't take a million dollars for my experience," he said, "but I wouldn't give a nickel for another three years."

He was emphatic in his belief that a method must be found to return experienced petroleum men to private industry.

"If the oil industry doesn't want the government to continue its controls," he said, "the industry has the responsibility of finding jobs for present government employes. In PAW alone there are more than 1000. If the industry fails to meet this challenge, the natural tendency would be for the government employes to seek to perpetuate their organization. I believe, however, that responsible government officials in Washington have every intention of handing the reins back to industry when peace comes."

During his service with PAW, Mr. Foulds organized and supervised the original fuel oil conversion program for the 32 Atlantic Coast and Midwestern States, reaching smaller oil users through press and radio and the larger consumers by direct mail and by personal contact. He delivered radio and other public addresses, helped prepare press releases and supervised the writing of more than 20,000 letters and telegrams. Meanwhile he guided the activities of a staff of combustion engineers.

The success of these efforts is demonstrated by the estimate that conversions actually completed between March 15, 1942, and July 15, 1942, saved 22,000,000 barrels of fuel oil annually.

In July, 1942, Mr. Foulds decentralized PAW conversion activities and organized a fuel oil section to cover the 17 Eastern Seaboard States, with headquarters in New York City. He next organized a similar section for the 15 Midwestern States with headquarters in Chicago. At the same time he was training men who organized the fuel oil sections in three other districts, with headquarters in Denver, Houston and Los Angeles.

Ned F. Foulds

Total reported savings from completed conversions during that period from March 15, 1942, to Oct. 15, 1943, exceeded 68,000,000 barrels. When the conversion goal was reached, Mr. Foulds ended all official oil conversion activity.

Incidentally, he is optimistic on prospects for fuel oil consumption after the war.

"I believe most accounts which patriotically converted from oil to coal will reconvert to oil as soon as they can," Mr. Foulds said. "An entirely new market will open up. The industry has discovered the public wants the convenience given by fuel oil, and is willing to pay for it."

In his present post with Industrial Oil and Gas Co., Mr. Foulds will supervise sales for New England, New York, New Jersey and Pennsylvania. His customers are large industrial consumers, public utilities and jobbers.

Before taking charge of the Fuel Oils Section of PAW, Mr. Foulds was chief of the Research and Statistical Section and, later, chief of the Materials Section. He was a co-author and then was administrator of one of the first orders (M-68-c) issued by PAW. This order controlled the use of petroleum marketing and liquefied petroleum gas equipment, and also governed the construction of new service stations. Mr. Foulds helped many manufacturers, affected by the provisions of the order, to obtain government contracts which enabled them to convert their plants to war production.

Before joining PAW, Mr. Foulds was for 10 years sales manager of the Southern New England Ice & Fuel Co., Inc. He started this concern in the fuel oil business in 1931. A decade later, fuel oil sales represented 47 per cent of the company's gross income.

Mr. Foulds also spent two years with the Standard Oil Co. (Ohio), where he was assistant to the division manager at Columbus and later assistant to the manager of the specialty department in Cleveland. He was born in Gate, Okla., is a graduate of Wichita University, Wichita, Kan., and holds an M.B.A. for a post-graduate course at Harvard Business School. Despite his wide range of experience, he is only 40 years old. He lives in an apartment hotel in the heart of Manhattan, where he has little or no opportunity to indulge in what he lists as his only two hobbies: gardening and woodworking.

Brochure Shows Gulf Workers How They Help War Effort

Special to NPN

PITTSBURGH—Employes of the Gulf Oil Corp. have been made aware of their very large part in America's war effort in a realistic manner. The company has just published an elaborate magazine style brochure which, in a graphic manner, directs their attention to the tremendous importance of oil in the prosecution of the war.

By means of both composition and graphic illustrations, the publication describes the part played by oil products in turning the tide of battle from the time of the attack on Pearl Harbor until the present.

In justifying the pride petroleum workers have in their war jobs, such subjects as the declaration of war, the Battle of the Atlantic, mobilization, the miracle of 100 octane gasoline, global war, synthetic rubber, TNT, gasoline rationing, war time service, fighters' food, pipelines, invasion, the war in the Pacific islands, and scores of other subjects are fully covered. It is a brief, vivid history of the present conflict, emphasizing the part played by oil and its by-products.

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OPA Owes Industry Explanation of Its Intentions On Newly Won Powers During 'Investigations'

By Elwin E. Hadlick

The Supreme Court's recent failure to decide many rationing questions perplexing to industry was commented on in our article in the June 14 issue of NPN. In that issue we outlined the one and only problem presented to the Court in the Steuart case, and the very precise manner in which the Court stuck to that point in rendering its decision.

Mr. Hadlick

It will be remembered that it was said there that the Supreme Court answered the only question before it by holding that the power to ration fuel oil includes as a necessary part thereof the power to issue suspension orders for violation thereof.

The difficulties of following Supreme Court decisions are as nothing compared with the impossible task of attempting to determine what the law is by the opinions of Federal District Courts and Circuit Courts of Appeals, made in advance of a pronouncement by the Supreme Court. These District and Circuit court decisions may and frequently are sustained; yet they are frequently reversed. Of necessity businessmen must follow them in order to keep their businesses running, because the time lag in getting questions settled by the Supreme Court is too great.

Wanted Private Inquiry

Shortly after the Supreme Court's decision in the Steuart case, there were three decisions in the Circuit Court of Appeals for the Seventh Circuit (Chicago), three decisions which have been variously commented upon in trade papers. We will comment here only on one of them.

The Circuit Court in one opinion disposed of a number of actions all involving activities of OPA in connection with one main proceeding. It is necessary to understand the nature of the case in order to apply the decision of the Court. OPA was investigating (not prosecuting) the activities of the Empire Packing Co. In connection with that investigation, it issued subpoenas to 15 persons who dealt with Empire, ordering them to appear at a specified time and place to testify concerning their transactions with the company for a certain period of time, and requiring them to bring with them all invoices, records and other documents, pertaining to the purchase of meat from the company for that period.

Those who received the subpoenas reported as directed; those involved in these cases had with them their attorneys and a court reporter. Apparently the Court was impressed, though not rightfully so, by the fact that all of the witnesses save one or two had as their attorney the same attorney who represented the Empire Packing Co. It seemed however that the proceeding, being in the nature of an investigation, had been planned by OPA to be a private affair and not a public one. Consequently, after a few preliminary questions, the OPA representative informed those who were present that the attorneys and court reporter would have to withdraw from the room. Attorneys and reporter refused to withdraw unless authorized by the clients, the clients refused to give such authorization, and the clients refused to testify in the absence of the attorneys and the reporter.

The accompanying article is the 16th in the series by Elwin E. Hadlick on how to obtain effective compliance with the government's war-oil regulations. This week Mr. Hadlick, prominent member of the Minnesota bar and executive head of the Northwest Petroleum Assn., comments on recent decisions of federal courts in Chicago. The Circuit Court of Appeals in that area draws a sharp distinction between a "hearing" and an "investigation" and holds that in the latter case witnesses are not entitled to be represented by counsel. Mr. Hadlick calls upon OPA for an explanation as to just what its procedure is going to be under this newly won authority.

Both Sides Dissatisfied

That took the case into the District Court, the move being made by OPA in the form of a request to the court that it order the witnesses to appear and testify, having with them their records but not their attorneys or court reporter. The District court gave the OPA what they were asking for, that is, it ordered the witnesses to appear and to testify without their attorneys and without their reporter. But the District court added a provision that the investigation must be open to the public, which could include the attorneys and the reporter so long as they did not interrupt or interfere with the proceedings.

OPA was dissatisfied with the District Court decision because of the requirement that the investigation be open to the public. The reason for the dissatisfaction of those who received the subpoenas is obvious. Both sides were thus appealing to the Circuit Court.

Crux of the case and foundation stone of the decision of the Circuit Court is contained in one short sentence, "This was an investigation, not a hearing." To a layman that sounds like playing on words. But the court goes on in such a way as to make its reasoning clear, even though we disagree with it. It says "investigations are informal proceedings held to obtain information, to govern future action and are not proceedings in which action is taken against anyone. Investigations have no parties and are usually held in private, just as a grand jury carries on its investigations in private."

In distinguishing an investigation from a hearing the court said "in a hearing there are parties, and issues of law and of fact to be tried, and at the conclusion of the hearing, action is taken which may materially affect the public. The parties to a hearing are entitled to be present in person and by counsel and to record the proceedings or be provided with a record by the hearing body. The parties to a hearing are entitled to participate therein.

Like Grand ury Inquiry

Then the court puts the clincher on the deal with the statement "these essential differences between an investigation and a hearing are what permit the two proceedings to be conducted in different manners". In other words, the Court decided that an OPA investigation is like a grand jury inquiry. That is mighty strange. The procedure for grand juries has been carefully set up by statute, yet the court justifies classing an OPA investigation with a grand jury inquiry by pointing out that there is nothing in the statute covering OPA prescribing the manner in which the investigations are to be held. That situation, the Court says, leaves it up to the Administrator to determine for himself how the investigation is to be conducted and regulated.

That kind of thinking naturally brought forth the conclusion by the Circuit Court that the District Court had no power to regulate the manner in which the investigation was to be conducted. The Circuit Court says that the only thing that the District Court could decide was (1) whether the Administrator was conducting an investigation, (2) whether he had subpoenaed the witnesses, and (3) whether the witnesses had refused to comply. That being its position, the natural result was that the District Court was held to be wrong in requiring the

hearing to be of a public nature; thus the OPA got exactly what it was seeking.

Lack Guidance of Precedent

If this decision of the Circuit Court stands, then persons who become involved with OPA should carefully determine the nature of the proceeding in which they are involved. If they find themselves subpoenaed in an OPA investigation they completely lack the guidance of precedent or rule. They enter the investigation without having any idea as to what the procedure is going to be. All they know is that according to the Court's decision, the Administrator for OPA is going to determine for himself how the investigation is to be conducted and regulated.

OPA officials should shudder at the responsibility which this decision places upon them. They have an immediate obligation to industry to issue a full and complete statement of what their procedure is going to be in the matter of investigations.

Another phase of this question which cannot be commented on completely in this article and one which has yet to be decided upon by the Courts is of extreme importance. While it is true as the Court says that grand jury investigations are in private, it is also true that if the grand jury returns an indictment, the evidence in the case must be presented to a trial jury from the beginning; it is not permissible to present to the trial jury as facts any conclusions drawn by the grand jury other than the mere fact that the grand jury after investigation found an indictment. A matter of extreme importance is the use which OPA will attempt to make in Court actions or suspension proceedings of the information developed in investigations.

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Complete texts of all orders or amendments digested in war-oil orders can be had from Platt's Oil-LAW-Gram, 1213 West 3rd street, Cleveland 13, Ohio. Minimum charge single copies $1. Copies of these texts are always in stock but large orders can be promptly filled by reprinting as plates and stencils are also kept.

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Index of Week's War-Oil Orders

(Issued June 24-July 1, 1944)

PAW—Petroleum Administration for War

PAO 11, SO 12—Relaxation of nationwide and District 3 drilling restrictions

PDO 22—Minimum viscosities established for fuel oil in District 5

PAW Wire to Dist. 2 Refiners—Increase of 80-octane all-purpose gasoline for armed forces

OPA—Office of Price Administration

MPR 88, Am. 11—Modification of general provisions and of 7 specific ceilings

MPR 136, Am. 120—Additions to machinery price Appendices B and C

Am. 121—Ceilings established by Price Administrator

RMPR 143, Am. 1—Implement tires and tubes excepted from minimum discount table; August 15, 1944 deadline for filing smaller discounts with OPA

Order 14, Am. 1—Corrections and additions to imported natural rubber tire and tube prices

MPR 528, Order 5—Firestone tractor tire ceilings

Rev. RO 11, Am. 14—Exceptions to 550 sq. ft. per stove limit; children's allowance

WPB—War Production Board

M-19, as am. 6-26-44—Chlorine allocation

M-84, as am. 6-28-44—Cordage restrictions revised

P-98-b, as am. 6-26-44—Procedure for obtaining critical materials simplified

CMP 1, Direction 52—Application for permission to use excess materials

Pri. Reg. 1, Direction 4—Application for permission to use excess materials

Congress of United States

S. 1764—House Report 1698—Stabilization Extension Act of 1944—Amendments to Emergency Price Control Act of 1942

CODE: AO—Administrative Order; CMP—Controlled Materials Plan; D—Directive; FDO—Food Distribution Order; GMPR—General Maximum Price Regulation; GO—General Order; Interp.—Interpretation; L—Limitation Order; M—Conservation Order; MPR—Maximum Price Regulation; P—Preference Rating Order; PAO—Petroleum Administrative Order; Pri. Reg.—Priorities Regulation; Proc. Reg.—Procedural Regulation; PS—Price Schedule; RO—Ration Order; RPS—Revised Price Schedule; SO—Supplementary Order; SR—Supplementary Regulation.

Digest of Week's War-Oil Orders

Petroleum Administration for War

RELAXATION OF NATIONWIDE AND DISTRICT 3 DRILLING RESTRICTIONS—PAO 11, SO 12—See story on page 8 this issue NPN.

MINIMUM VISCOSITIES ESTABLISHED FOR FUEL OIL IN DISTRICT 5—PDO 22—Viscosity minima set for following grades fuel oil: furnace, light domestic, bunker grade, railroad and heavy industrial. See story p. 44 this issue NPN. Issued and effective 6-28.

INCREASE OF 80-OCTANE ALL PURPOSE GASOLINE FOR ARMED FORCES—Form of PAW Wire to Dist. 2 Refiners—26 refiners, controlling 35 refineries in District 2, assigned June production quotas of 80-octane all-purpose gasoline for delivery to armed forces. These refiners eligible for allocation of civilian gasoline needs from other refiners, as directed by 5-18 Wire, reviewed on p. 43 of 5-31-44 issue NPN. Issued 6-19.

Office of Price Administration

MODIFICATION OF GENERAL PROVISIONS AND OF 7 SPECIFIC CEILINGS—MPR 88, Am. 11—See story on p. 42 this issue NPN. Issued 6-26, effective 7-1.

ADDITIONS TO MACHINERY PRICE APPENDICES B AND C—MPR 136, Am. 120—Base date of 3-31-42 is applicable to ceilings on bearings and bushings, excepting those covered by MPR 188, 241, 244, RPS 41, or RMPR 125, or those which are assigned 10-1-41 base date by Appendix A of MPR 136. Ferrous and non-ferrous castings are excluded from MPR 136's jurisdiction, being covered by RPS 41, RMPR 125, MPR 241, MPR 244. Issued 6-26, effective 7-1.

CEILINGS ESTABLISHED BY PRICE ADMINISTRATOR—MPR 136, Am. 121—Machines, parts, or machinery services sold without computing ceiling according to various formulas outlined in 136, will take ceiling established by written order of Price Administrator. Such ceiling will be in line with those established by 136, and will apply to all sales or deliveries of such machine, part, or service made after 7-22-42. Issued 6-27, effective 7-3.

IMPLEMENT TIRES AND TUBES EXCEPTED FROM MINIMUM DISCOUNT TABLE; AUGUST 15, 1944 DEADLINE FOR FILING SMALLER DISCOUNTS WITH OPA—RMPR 143, Am. 1—Implement, as well as tractor tires and tubes, excepted from minimum discount table of 143. Deadline for filing with OPA price established under MPR 143, before RMPR 143 was effective, based on a discount smaller than that in table, is now 8-15-44, instead of 15 days from effective date of RMPR 143. Issued 6-29, effective 7-5.

CORRECTION AND ADDITIONS TO IMPORTED NATURAL RUBBER TIRE AND TUBE PRICES—RMPR 143, Order 14, Am. 1—Ceiling for 6.00 x 18 6-ply passenger car tire corrected to read $25.05 instead of $20.05. Retail ceilings for new passenger car tires apply to all tires of listed size, including white or black-white sidewall tires, and mud and snow-tread tires. Ceilings on additional sizes listed for passenger car and truck tires and tubes. Issued 6-27, effective 6-28.

FIRESTONE TRACTOR TIRE CEILINGS—MPR 528, Order 5—Firestone farm tractor rear tire retail ceiling is $52.85; front tire ceiling $25.00 for 8-ply 7.50-10, $9.55 for 4-ply 4.00-12. Issued 6-26, effective 6-27.

EXCEPTIONS TO 550 SQ. FT. PER STOVE LIMIT; CHILDREN'S ALLOWANCE—Rev. RO 11, Am. 14—In Zone D up to 950 sq. ft. of floor area may be counted for each non-portable space heater; up to 850 sq. ft. in Zones A3, B3, and C3 for each circulating heater having 50,000 or more B.T.U. output. Up to 10% may be added to the renewed ration if one or more children under 6 regularly live in the premises, but permissible maximum for each zone is listed in special section. Issued 6-28, effective 7-3.

War Production Board

CHLORINE ALLOCATION—M-19, as am. 6-26-44—Application for allocation for use made on WPB-2908 (old PD-190), for allocation for distributor's delivery on WPB-927 (old PD-191). Diversion to use other than one specified may be made only by filing WPB-2908 or letter to WPB in triplicate. Small delivery exemption—containers of less than 1 ton capacity. Inventory restricted to 30-day supply. Issued 6-26.

CORDAGE RESTRICTIONS—M-84 as am. 6-28-44—Processors are now given AA-1 rating instead of AA-3 to get istle and jute yarns

for processing into rope. Processor's basic monthly poundage of manila for rope processing cut to 83.25% (from 111%); of agave increased to 583% (from 530%). American hemp must now be used as an extender in all agave sisalana rope except that under ¾ in. diameter, and except wire rope centers and drilling cables. Manila rope made before 7-1-44 may be sold and used in conformity with M-84 as amended 4-5-44. Issued 6-28.

PROCEDURE FOR OBTAINING CRITICAL MATERIALS SIMPLIFIED—P-98-b, as am. 6-26-44—Priorities assistance for materials necessary to the petroleum industry simplified, to reduce paper-work to a minimum. See story p. 7, June 28, NPN. Issued 6-26.

APPLICATION FOR PERMISSION TO USE EXCESS CONTROLLED MATERIALS—CMP 1, Direction 52—Permission to use materials on hand which cannot now be used for purpose originally intended will be given upon application by letter to WPB, in duplicate, if conditions are same as those required by Pri. Reg. 13 for purchase of frozen or excess materials. No authorization will permit exceptions to any E, L, or M order restrictions. Issued 6-24.

APPLICATION FOR PERMISSION TO USE EXCESS MATERIALS—Pri. Reg. 1, Direction 4—Text of this direction is identical with that of Direction 52 to CMP 1, reviewed above. Issued 6-24.

Congress of the United States

MODIFICATION OF OPA'S PROCEDURE IN ENFORCEMENT OF PRICE ORDERS—Stabilization Extension Act of 1944—Amendments to the Emergency Price Control Act of 1942 by Senate Bill 1764, House Report 1698, extend the term of price control to June 30, 1945. Portions of text of order printed in NPN of 6-28, pp. 8-9, set forth change in enforcement procedure, giving established courts greater power over proceedings, and OPA itself, less. Released 6-23, effective 7-1, expires 6-30-45.

4 General, 9 Local Changes Made in MPR 88

NPN News Bureau

WASHINGTON—OPA last week announced 13 changes in MPR88 four of which are applicable to sellers throughout the U.S., with remaining nine representing modifications of ceiling provisions for specific localities.

All of the changes are embodied in an amendment—No. 11 to MPR88, effective July 1—which is being made part of the regulation in a collation of all amendments issued to date. The 13 changes made by the latest amendment and collation follow:

1. The April 14, 1944, action providing that, where crude oil conforming to commercial standard specifications of fuel oil is sold direct to consumers for use as fuel oil, ceilings would be established by OPA regional offices upon application, is replaced by the following broader policy: All crude sold to consumers for purposes other than refining, or sold to tank wagon resellers for resale for purposes other than refining, will have ceilings established by OPA at Washington, D. C., upon application unless a price can be determined under the formula provisions applicable also to sales of fuel oil.

2. Sellers who have no ceiling prices on petroleum products for a particular shipping or delivery point where other sellers do have maximum prices may adopt only such maximum prices of other sellers as are determined on the basis of the last sale of the same product at the same point to the same class of purchaser in the 60-day period preceding Oct. 15, 1941.

3. Special hydrocarbon fractions when sold for use in the manufacture of components of synthetic rubber, aviation gasoline and toluene will be exempt from price control.

4. The specific ceiling prices established April 20, 1944, for Connecticut on No. 2 and No. 3 fuel oils at wholesale and retail levels are made applicable to No. 4 distillate fuel oil. At the same time, the maximum yard price at barge terminal operators' yards in the Hartford area is reduced 0.10c per gal. to 7.4c to conform with formula ceiling prevailing prior to April 20. In the Waterbury area, a specific ceiling of 7.8c per gal. is re-established for "yard" sales, this ceiling having been inadvertently omitted from the April 20 action.

5. The maximum tank wagon prices to consumers in New Hampshire on kerosine, No. 1 fuel oil, range oil, and Nos. 2 and 3 fuel oil, established April 25, 1944, are made applicable on sales to resellers. This will simplify pricing on these sales and will cause no change in the overall level of prices.

6. The 10.3c per gal. ceiling on kerosine, No. 1 fuel oil and range oil deliveries by truck in New York City, when such deliveries to consumers are in containers in quantities of 50 gal. or more, will not apply when deliveries are made in returnable steel barrels with an individual capacity of more than 50 gal. Sellers may use their customary formula method in determining ceilings on sales in returnable steel barrels.

7. Three changes are made in tankwagon ceiling prices for Nos. 2 and 3 fuel oil in Maine, as follows: Biddeford-Saco and Kennebunk areas, 9.2c per gal; town of Alfred, 9.3c per gal.; town of Berwick, 9.3c per gal. Previous ceilings were 9c, 9c and 9.2c, respectively.

8. At Pawtucket, R. I., a ceiling of 7.3c per gal. is set for sales of Nos. 2 and 3 fuel oil loaded into tankwagons except at jobbers' inland bulk plants. This compares with 7.1c erroneously established March 21, 1944.

9. The tankwagon ceiling for gasoline in Lake City, Colo., will no longer be 11.5c per gal. as in the balance of the Creede tankwagon area. Instead, sellers will be allowed to charge their base period price.

10. In the Henderson, Ky., tank wagon area price ceilings for gasoline are established at 11.5c per gal. for Premium grade, 10c per gal. for Regular grade, and 9c per gal. for Third grade. Previous ceilings were 1.5c lower on each grade, but it has been shown that they were out of line with those in surrounding areas and have caused financial hardship.

11. Refiners in Lake, Porter and La Porte Counties in Indiana will have the same ceiling price for 7-0-2 Diesel fuel f.o.b. their terminals as was previously spelled out only on sales f.o.b. refineries. These prices apply only on sales to the Government. Prices established on May 1, 1944 for 7-0-2d Diesel fuel now apply to any 7-0-2 Navy Specification diesel fuel.

12. In California, sellers who in the base period sold a residual fuel oil conforming in specification to P.S.300 residual fuel oil except for a viscosity of only 18-24 seconds will be able to add 25c per bbl. to their base period prices for the lighter fuel oil, providing that their base period prices for the lighter fuel oil were in line with the price then charged for P.S. 300 fuel oil.

13. Where a person is either an eligible broker or an eligible marketer, he will be entitled to act in either capacity.

Early Rationing of Naphtha Waits on WPB Directive

NPN News Bureau

WASHINGTON—An OPA program for rationing naphtha, developed and discussed with industry members at a meeting here June 20, has been blueprinted in general outline but with a few specific details still to be filled in, and OPA is only awaiting a directive from WPB before laying definite plans to institute it, NPN learned this week.

The five or six industry members who met with OPA a week ago are said to feel that naphtha rationing will be a "very nasty" job, but were in general agreement that this probably is the only way to control its distribution.

Practically the same problems will be involved in rationing naphtha that have been experienced in rationing non-highway gasoline, it is thought, and, in this connection, it is pointed out that OPA has been rationing gasoline to farmers and other off-highway consumers for over two years and this is still working far from perfectly.

If and when OPA does institute naphtha rationing, the terms of the program will be rather arbitrary, in that there are no facts or figures available as to the needs of individuals for dry cleaning, or for such establishments as dry cleaning shops.

Developments on the problem have been discussed from time to time by OPA with PAW, and the final program will be talked over with the oil agency before it is put into effect. OPA action may come after PAW has recommended to WPB that naphtha be rationed.

Wise refiners appreciate the cost-wise advantages of Houdry-licensed processes.

Properly engineered refineries, using Houdry fixed bed and T.C.C. crackers, provide commercial advantages which go much farther than low capital cost per barrel of throughput. These advantages involve yield of liquid fuels, lead susceptibility of products, cost of make-up catalyst, long life of equipment and other factors.

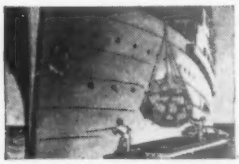
HOUDRY PROCESS CORPORATION
WILMINGTON, DELAWARE

HOUDRY CATALYTIC PROCESSES ... FOR VICTORY IN WAR ... FOR PROGRESS IN PEACE

Houdry Catalytic Processes and the T.C.C. Process are available through the following licensing agents to all American refiners, subject to approval by the United States Government.

BECHTEL-McCONE-PARSONS CORP. Los Angeles, California • THE LUMMUS COMPANY New York City, New York • E. B. BADGER & SONS CO. Boston, Massachusetts

Up from the Sea ...In "Ducks"



A new and secret weapon until a few months ago, the GMC "Duck" has now become a valued veteran of invasion campaigns from Sicily to the South Pacific. Part boat and part truck, it combines the performance and advantages of both. Loaded with fighters, food or fighting equipment, it can travel from ship to shore, and back again, with a simple shifting of controls. On land, the "Duck's" powerful engine and sturdy, six-wheel drive chassis carry it over regular road or tough terrain, right along with the famous GMC 2½ ton, "six-by-six" Army truck. In the water, chassis and tires add stability and seaworthiness to the big, buoyant, all-steel hull, making for "smooth sailing" in heavy surf and high seas. Since our earliest wars, America's fighters have gone *Down To The Sea In Ships.* This is the first time they have come *Up From The Sea In Amphibian Trucks!*

GMC TRUCK & COACH DIVISION
GENERAL MOTORS

Home of Commercial GMC Trucks and GM Coaches . . .
Volume Producer of GMC Army Trucks and Amphibian "Ducks"

War-Oil Compliance

Minimum Viscosities Are Set For West Coast Fuel Oils

NPN News Bureau

WASHINGTON—PAW this week set minimum viscosities for various grades of civilian fuel oils to be manufactured, delivered, or received in the Pacific Coast states with issuance of Petroleum Distribution order 22, effective June 28, and applying only to PAW Dist. 5.

Viscosity minima for various grades of fuel oil listed by PDO 22 follow:

Furnace oil—not less that 43 Saybolt seconds universal at 100 deg. F.; light domestic fuel—not less than 35 Saybolt seconds furol at 122 deg. F.; bunker grade fuel—not less than 150 Saybolt seconds furol at 122 deg. F.; and railroad and heavy industrial fuel—not less than 200 Saybolt second furol at 122 deg. F.

Deputy PAW Davies said the order will have "very little effect" upon total civilian supply of fuel oil but pointed out that in some instances it may become necessary for civilians to adjust their oil burners slightly to use the fuel oil at maximum heating efficiency.

Mr. Davies explained the need for order as follows:

"It is necessary to protect the nation's supply of 100-octane aviation gasoline, Navy special fuel, Navy Diesel oil, and other petroleum products required by the armed forces. Since these products in part come from the same cuts of crude oil that also produce home heating and industrial fuel oils, it has been deemed necessary to establish minimum viscosities for civilian fuel oils.

"This means that fuel oils for civilians will be maintained at viscosities under which the oils will continue to perform efficiently in burners without requiring greater quantities of oil to produce the same heat as formerly and, at the same time, will insure the availability of certain fractions of the crude oil for the manufacture of petroleum products for the military."

Authority to administer PDO 22 has been delegated to the director-in-charge of Dist. 5.

7000 New Cars Is July Quota; Total Stocks Shrink to 30,000

NPN News Bureau

WASHINGTON—OPA this week announced that there will be only 7000 new passenger cars available for rationing during July, a reduction of 22% from June, and 30% less than the quota for May.

Regional and national reserves of 600 cars each—making total reserves of 1200 cars—have also been assigned for July. These are set up to provide for emergency needs when quotas have been used up.

At the same time, OPA reported that the original stock of 530,000 new cars available on Feb. 1, 1942, has shrunk to about 30,000 units, the equivalent of a three-days normal supply.

'24 to '44

20 Years of Unquestioned Quality Enjoyed by Sellers and Users of 100% Pure Pennsylvania Motor Oils

Since the emblem of the Pennsylvania Grade Crude Oil Association first came into being—in 1924—it has been the oil-mark of top quality lubrication. The emblem has been widely advertised, too, but all the power of advertising can't sell poor oil to the same man twice. Emblem Pennsylvania Oils have been steady repeat-sellers—winning friends and holding them—simply because their *performance* has fulfilled every advertisement we ever published.

The quality of 100% Pure Pennsylvania Motor Oil—as every oil man knows—stems from the crude oil from which they're made—Pennsylvania Grade Crude. From this better raw material, a better finished product is a natural result because Pennsylvania refiners, of course, keep always abreast of proved refining advancements.

You are always sure of Pennsylvania quality, and that is a big reason why motor oils entitled to our emblem should be an important factor in your business today...

AND A VITAL FACTOR IN YOUR POST-WAR TOMORROW.

Inquiries invited.

PENNSYLVANIA GRADE CRUDE OIL ASSOCIATION

OIL CITY, PENNSYLVANIA

Because of its high quality, war demands great quantities of 100% Pure Pennsylvania Motor Oils and this demand comes first, of course. Our region is producing and refining to the limit. Our oils are still available most everywhere for essential motoring needs.

Dist. 2 Drive To Show Public Oil Must Be Saved Gains Impetus in Meetings, Press and on Radio

NPN News Bureau

CHICAGO—The Dist. 2 Products Conservation Committee program is in full swing, carrying out the plan to educate the public on the need and reasons for gasoline rationing with meetings explaining the purpose in almost every sizable community in the district. OPA is giving its support to the campaign, state committee chairmen say, to correct its earlier mistake in instituting rationing without firmly implanting the need for it in the minds of the rationed public. Many newspapers are printing editorials on gasoline saving and industry men are giving their time and energy.

Oklahoma, under the chairmanship of J. Gilbert Davis of Continental Oil Co., has had its program held in check by the harvest of what is expected to be the state's largest wheat crop in some time, but nevertheless has held six meetings before civic groups and expects to raise that number to 50. Mr. Davis said that, in connection with the campaign, OPA was planning to have its Oklahoma personnel help blanket the state with speakers. Reaction of the public to the meetings held so far, Mr. Davis explained, has been one of respectful consideration.

Michigan Reports Progress

John W. Jankowiak, co-chairman of the Michigan committee, and president of the Michigan Petroleum Assn., told of the association's part in the campaign —contacting every jobber in the state with a series of letters explaining the situation. While the various subcommittees holding meetings, have not yet submitted their reports to the state committee, results, he said, are showing some improvement although it has not yet reached the point hoped for.

The Missouri Product Conservation Committee has appointed 70 men to subcommittees in different sections of the state to arrange for speeches before civic organizations. About 14 have been held so far and the committee plans to cover the entire state. At a meeting in Clinton, Mo., arranged by R. J. Wastell, one of the committee members, attendance reached the 1500 mark while 400 persons attended one of the meetings in Kansas City according to Roy Blair, co-chairman with Harold F. Nelson of the Missouri committee.

The Ohio Product Conservation Committee is utilizing the knowledge and experience of the industry men appointed to the OPA gasoline advisory committee in its organizational setup by appointing them members of the state committee. Under the state committee are the district committees and under them, the county committees. OPA has organized a committee made up of members of the various civic organizations in Ohio with which the conservation committee will work in planning speeches before all civic organizations in the state. District OPA men have attended the meetings as have many of the regional OPA men.

Radio Campaign in Indiana

E. V. Weber, president of the Ohio Petroleum Marketers Association, Inc. and co-chairman with A. A. Stambaugh of Standard of Ohio, credited much of the committees' success with newspaper publicity to Standard of Ohio's loan of its public relations man, John Weiland, who is devoting a great deal of his time to putting the idea across. The Ohio committee is now working out plans to put their appeal on the air over an OPA-sponsored program. The Ohio committee's work is credited by OPA for substantial reduction in counterfeit coupons, Mr. Weber said.

Phil T. Williams, Indiana Independent Petroleum Marketers Association, and J. G. Sinclair, Shell Oil Co., chairmen of the Indiana committee, have arranged for radio coverage on their campaign through the Hoosier Automobile Club, along with the scheduled program of meetings throughout the state.

The Kentucky, Minnesota and North Dakota committees are still in the process of organizing but plan to follow the program outlined by the Dist. 2 Products Conservation Committee. E. E. Hadlick, Northwest Petroleum Association, and T. B. Murphy, Deep Rock, who as co-chairmen handle the arrangements for Minnesota and North Dakota jointly, plan to hold a meeting in every town of more than 5000 population.

Lain Dunagin, Kansas Oil Men's Association, who with E. C. Fleming, Skelly Oil Co., acts as co-chairman of the Kansas committee, commented on the co-operation received from all sides in the setup under which they have already had 18 meetings. OPA, the civic organizations and the newspapers have all been exceptionally helpful, he said.

The Illinois Petroleum Conservation Committee was to hold a meeting July 6 at the Lake Shore Athletic Club to which agents, plant managers, sales personnel and other oil company representatives in the Illinois Dist. 1, which covers Cook, Lake, du Page, Will and Kankakee Counties, were invited. The importance of petroleum products in modern warfare was to be illustrated by one of the latest official war pictures of the invasion of a Jap held island.

Adding further impetus, Ernest L. Hughes, PAW Director of Distribution and Marketing, told the story behind fuel oil rationing in a radio interview July 2.

Coming Meetings

SEPTEMBER

American Chemical Society, New York City, Sept. 11-15.

Empire State Petroleum Assn., Inc., fall meeting, Hotel Commodore, New York City, Sept. 20-21.

OCTOBER

American Assn. of Oil Well Drilling Contractors, annual meeting, Ft. Worth, Oct. 3-4.

Indiana Independent Petroleum Assn., fall meeting, Indianapolis, Oct. 11-12.

I.P.A.A., annual meeting, Dallas, Oct. 23-25.

Ohio Petroleum Marketers Assn., Deshler-Wallick Hotel, Columbus, O., Oct. 25-26.

NOVEMBER

A.P.I., silver jubilee, Stevens Hotel, Chicago, Nov. 13-16.

South Dakota Independent Oil Men's Assn., Mitchell, S. D., Nov. 27-28.

National Petroleum News

Established February, 1909

Published every Wednesday by The National Petroleum Publishing Co.

WARREN C. PLATT, *Editor and Publisher*

A. E. KRAFT, *Treasurer*

V. B. GUTHRIE, *Associate and Technical Editor*

V. C. REPPETO, *Managing Editor*

Y. A. KOSKINEN, *Advertising Manager*

Member of Audit Bureau of Circulation and Associated Business Papers, Inc.

Publication office: 1213 W. Third St., Cleveland 13, Ohio, U. S. A. Telephone, CHerry 7672. Cable Address PLATTOIL, Cleveland. Cable inquiries are answered by mail unless subscriber advances sufficient funds in American money to cover our cable cost.

NEWS BUREAUS

New York 20, 50 W. 50th Street, Telephone Columbus 5-1516 and 5-1517.

Washington 4, D. C., 1034-36-38 National Press Bldg., Telephone NAtional 3477.

Tulsa 3, Okla., 904 World Bldg., Telephone 3-7132.

Los Angeles 14, 610-A Hillstreet Bldg., Telephone VAndike 2845.

Chicago 5, 59 E. Van Buren Street, Telephone HARrison 5901-2-3.

Subscription rate $5 per year in United States, Mexico and Pan-American Countries; $6.50 in Canada and Foreign Countries. Current copies 20 cents, except special issues; back copies more than two months old 30 cents per copy.

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OPA Suspensions Now to Hang On Violation, Not on Price

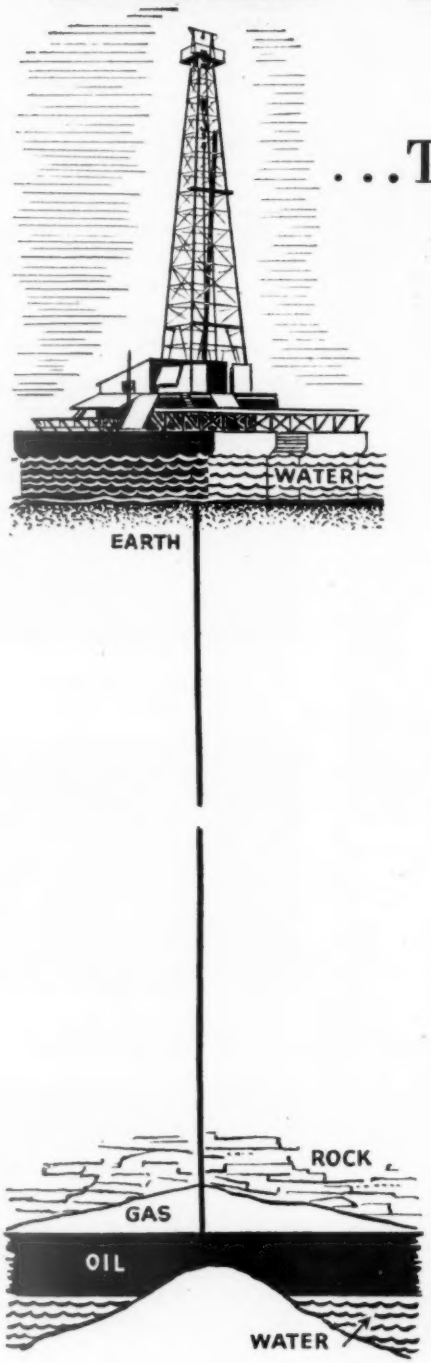
NPN News Bureau

WASHINGTON—Dealers no longer may be deprived of the right to buy or sell rationed goods because of a violation of OPA price ceilings on a rationed article, OPA announced this week.

Formal action making this change was taken in Amendment 9 to General Ration Order 8, effective July 1, to bring rationing regulations into conformity with the Stabilization Extension Act, which became effective June 30.

However, OPA emphasized: "No change of any kind is made in OPA's authority to restrict or forbid a dealer who violates a rationing regulation (as distinct from a price regulation) from dealing in rationed commodities."

DEEP HORIZONS



...Tapped from a marine location with the

TEXACO SUBMERSIBLE DRILLING BARGE

As the need for oil becomes more intense the field of exploration from marine locations becomes wider, the search for oil-producing formations goes deeper. Today in fact it is being carried to record depths.

And—proving just as efficient for 13,000 ft. holes as it has been for the many wells drilled to 10,000 ft. in the past is the *Texaco Submersible Drilling Barge.*

This portable, producing unit is making accessible deep producing horizons from marshy and marine locations.

TEXACO DEVELOPMENT CORPORATION

A subsidiary of The Texas Company

26 Journal Square • Jersey City, N. J.

Refinery Operations

(American Petroleum Institute figures in thousands of barrels of 42 gal. each. Figures include reported totals plus estimate of unreported amounts and are therefore on a Bureau of Mines basis.)

Districts	Daily Potential Refining Capacity Week Ended June 24	Daily Potential Refining Capacity Week Ended June 17	Per Cent of Refining Capacity Reporting Week Ended June 24	Per Cent of Refining Capacity Reporting Week Ended June 17	Daily Average Crude Runs to Stills Week Ended June 24	Daily Average Crude Runs to Stills Week Ended June 17	Per Cent of Reporting Capacity Operated Week Ended June 24	Per Cent of Reporting Capacity Operated Week Ended June 17
Combined**	2,518	2,518	90.3	90.3	2,373	2,510	94.2	99.7
Appalachian (Dist. No. 1)	130	130	83.9	83.9	101	98	77.7	75.4
Appalachian (Dist. No. 2)	47	47	87.2	87.2	55	53	117.0	112.8
Ind., Ill., Ky.	824	824	85.2	85.2	768	779	93.2	94.5
Okla., Kans., Mo.	418	418	80.2	80.2	376	372	90.0	89.0
Rocky Mt. (Dist. No. 3)	13	13	17.0	17.0	12	13	92.3	100.0
Rocky Mt. (Dist. No. 4)	141	141	58.3	58.3	110	106	78.0	75.2
California	817	817	89.9	89.9	843	821	103.2	100.5
Total U. S.—B. of M. Basis	4,908	4,908	87.2	87.2	4,638	4,752	94.5	96.8
U. S.—B. of M. Basis June 26, 1943					4,007			

Districts	Gasoline Production at Refineries inc. Natural Blended Week Ended June 24	Gasoline Production at Refineries inc. Natural Blended Week Ended June 17	Stocks of Finished and Unfinished Gasoline Week Ended June 24	Stocks of Finished and Unfinished Gasoline Week Ended June 17	Total Stocks Gas Oil & Distillates Week Ended June 24	Total Stocks Gas Oil & Distillates Week Ended June 17	Total Stocks Residual Fuel Oil Week Ended June 24	Total Stocks Residual Fuel Oil Week Ended June 17
Combined**	7,021	7,255	37,461	37,556	18,647	18,015	15,768	15,840
Appalachian (Dist. No. 1)	319	301	2,418	2,057	439	749	278	265
Appalachian (Dist. No. 2)	181	162	1,324	1,046	172	406	209	209
Ind., Ill., Ky.	2,708	2,686	19,016	18,604	5,287	5,431	3,339	3,201
Okla., Kans., Mo.	1,331	1,291	7,593	7,782	1,515	1,344	1,398	1,367
Rocky Mt. (Dist. No. 3)	34	36	69	68	4	4	29	29
Rocky Mt. (Dist. No. 4)	385	405	2,433	2,469	334	339	647	610
California	2,087	2,262	15,686	15,686	7,930	7,849	31,089	30,496
Total U. S.—B. of M. Basis	14,066	14,938	*86,000	85,268	34,328	34,137	52,757	52,017
U. S.—B. of M. Basis June 26, 1943	11,360		78,960		32,232		67,240	

*Finished 73,884,000 bbls.; Unfinished 12,156,000 bbls.

**Includes East Coast, Inland Texas, Texas Gulf, Louisiana Gulf and North Louisiana-Arkansas districts.

U. S. Crude Oil Production

(American Petroleum Institute figures)

	WEEK ENDED June 24 Barrels (Daily Average)	WEEK ENDED June 17 Barrels (Daily Average)
Oklahoma	332,300	331,950
Kansas	289,700	284,200
Nebraska	1,000	1,000
Texas	2,036,400	2,036,400
Louisiana	362,950	362,800
Arkansas	80,250	80,300
Mississippi	45,350	42,950
Alabama	100	100
Florida	50	50
Illinois	209,550	205,650
Indiana	12,900	12,400
Eastern (Ill., Ind. & Ky. excluded)	66,800	69,200
Kentucky	21,750	19,250
Michigan	47,200	50,200
Wyoming	91,450	84,200
Montana	21,300	21,300
Colorado	8,350	8,150
New Mexico	108,000	107,950
California	847,800	850,200
Total, U. S.	4,583,200	4,568,250

Crude Oil Stocks

(Bureau of Mines Figures in thousands of bbls.)

Grade or Origin	June 17	June 24	Change from June 17
Penna. Grade	2,690	2,650	— 40
Other Appalachian	1,566	1,453	—113
Lima-Michigan	925	924	— 1
Illinois-Indiana	14,972	14,852	—120
Arkansas	2,830	2,759	— 71
Kansas	8,250	8,898	+648
Louisiana:	13,638	13,540	— 98
Northern	3,497	3,393	—104
Gulf Coast	10,141	10,147	+ 6
Mississippi	1,109	866	—243
New Mexico	6,499	6,588	+ 89
Oklahoma	32,128	31,775	—353
Texas:	112,009	111,937	— 72
East Texas	21,103	21,582	+479
West Texas	30,127	30,877	+750
Gulf Texas	32,351	31,203	—1,148
Other Texas	28,428	28,275	—153
Panhandle	6,271	6,309	+ 38
North	6,376	6,207	—169
South	5,896	5,948	+ 52
Other	9,885	9,811	— 74
Rocky Mountain	8,993	8,879	—114
California	22,585	22,059	—526
Foreign	2,371	2,152	—219
Total gasoline-bearing in U. S.	230,565	229,332	—1,233
Heavy in California	5,897	5,895	— 2

Crude Production & Runs to Stills

(Millions of Barrels)

Crude Output
Runs to Stills
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D 1 8 15 22 29 6 13 20 27 3 10 17 24
1942
1943
1944
APR.
MAY
JUNE

N.P.N. Gasoline Index

	Dealer T.W. Cents Per Gal.	Tank Car Cents Per Gal.
July 3	10.51	6.17
Month ago	10.51	6.17
Year ago	10.37	6.75

Dealer index is an average of "undivided" dealer prices, ex-tax, in 50 cities.

Tank car index is weighted average of following wholesale markets for regular-grade gasoline, FOB refineries or terminals: Okla., Mid-Western, W. Penna., Calif., N. Y. Harbor, Philadelphia, Jacksonville, Boston and Gulf Coast.

Pennsylvania Crude Runs

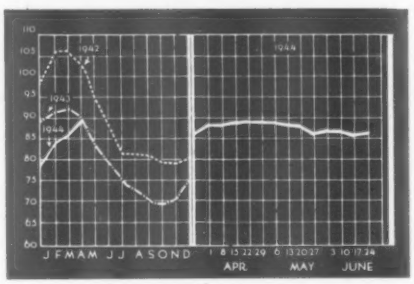
(Compiled by National Petroleum Assn. from reports of all companies refining Pennsylvania crude. Figures in bbls.)

DAILY AVERAGE

Week Ended June 24, 1944	Week Ended June 17, 1944	Week Ended June 26, 1943
72,244	65,748	69,551

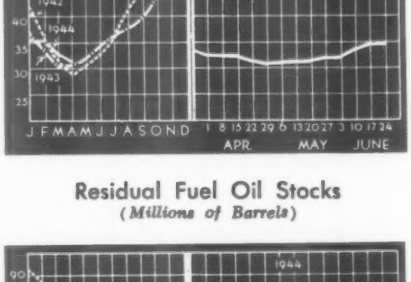
Gasoline Stocks

(Millions of Barrels)



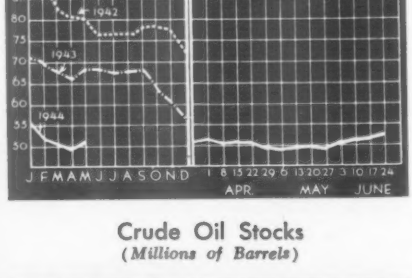
Gas Oil & Distillate Stocks

(Millions of Barrels)



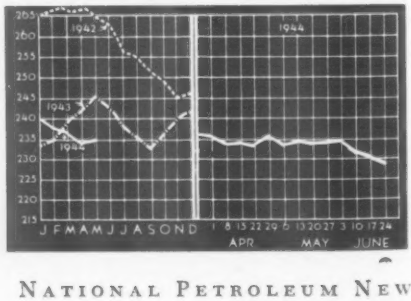
Residual Fuel Oil Stocks

(Millions of Barrels)



Crude Oil Stocks

(Millions of Barrels)



Market Reports

MIDCONTINENT — Transport truck transportation grows increasingly worse as wheat harvest brings heavy call for gasoline necessitating increase in number of requests for ODT permits to ship by tank car. Even with permits, difficulty in getting cars causes delay in filling orders and gasoline inventories are going down rapidly, refiners say. Although kerosine demand has fallen off considerably Navy Diesel need prevents refiners accumulating storage. Railroads continue taking all available residual, according to reports.

Only refiner quoting on black oil withdrew posting of 5.5c retroactive to Feb. 19, 1944, leaving no price for the product. No other quotation changes reported.

Two cars Grade 26-70 natural gasoline reported sold at 4.75c f.o.b. Group 3. No open spot sales reported f.o.b. Breckenridge, sellers quoted 4.375c during the week.

° ° °

GULF COAST — Refiner quoting 4.125c on 41-43 kerosine in barges, cargoes and tank car lots withdrew his quotation because he is making only gasoline. Price range unaffected. Step up in production of aviation fuels continues to hamper market for civilian needs. All products are reported tight.

° ° °

MIDWEST—Restrictions on manufacture of premium gasoline have forced discontinuance of inter-refinery sales which some refiners were depending upon to supplement their own production while housebrand gasoline markets, too, are tightening up. Marketers and refiners alike complain that a shortage of housebrand is developing while third grade gasoline is available only in negligible quantities.

Marketers and refiners report heating oil markets continue to tighten with some further increase in filling summer storages noted. Residual oils are in strong demand with railroads and war industries absorbing all available. Lubricating oil markets are holding steady.

No price changes were reported last week from either refiners or marketers. Prices in general are at ceiling on all products.

° ° °

ATLANTIC COAST—Gasoline situation along the East Coast grew tighter as southern suppliers reported heavy drain of housebrand gasoline supplies which were sufficient to meet only regular trade. PAW order to cut back refinery yields of premium gasoline met with little opposition by eastern marketers. Many predicted smaller profit margins but willingly put need of armed forces above personal gains. Since about 80% of gasoline sold throughout Baltimore area is premium, situation there is tight.

New York distributor quoting $1.77 on 15.9 gravity Bunker "C" broadened his range to $1.65-2.01. The high of $2.07 remained at New York Harbor. Kerosine supplies remained "spotty" Supplier in New York area reported limited stocks of kerosine and added that slow movement of barges has added to shortage.

° ° °

PENNSYLVANIA — Lower field Penna. refiner advanced his quotation 0.25c for untreated naphtha to 7.25c, making range 7-7.25c. Kerosine demand was strong during earlier part of week, but stocks remained easy and refiners were able to keep up with orders. Fuel oils were very much in demand with inquiries heavy for neutrals and bright stock but low stock and lack of material make them unavailable. Gasoline was reported to be moving out as fast as it is being made and refiners working on daily production. Domestic demand for wax still strong as building of inventories continues.

° ° °

CALIFORNIA—Reduction in premium gasoline quotas has greatly disturbed independent refiners. Many had converted their entire output to the premium grade and the cutback will seriously reduce income.

Many gasoline stations in Los Angeles area now post signs, "No limit, all the gas you want." This is a considerable turnabout from a few months back when more than half the stations displayed signs reading "Today's allowable sold."

However, the gasoline price is holding firm with the independents quoting about 1c under the major company tank wagon delivered price.

The lessening of pressure on the gasoline market is mainly attributable to better control of rationing, it is said.

CRUDE PRICES

Since changes in crude oil prices are so few, the two pages of crude oil price tables hereafter will be printed only when there are sufficient changes in prices to warrant.

In the meantime a record is being kept in the Cleveland office of NPN and OILGRAM from which the publishers will be glad to make proofs, or letters or affidavits as to what the prices are, and without charge to regular subscribers.

Crude Price Changes

No changes reported during week ended June 27. For latest table of crude prices published, see NPN, June 14, pages 61, 62 and 56.

Summary of Daily Gasoline Prices (June 26 to July 3)

	Monday July 3	Friday June 30	Thursday June 29	Wednesday June 28	Tuesday June 27
U. S. Motor (ASTM octane)					
76 octane Ethyl:					
Oklahoma	6.75	6.75	6.75	6.75	6.7
Mid-Western (Group 3 basis)	6.75 - 7.25	6.75 - 7.25	6.75 - 7.25	6.75 - 7.25	6.75 - 7.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7	7	7	7	7
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	7 (2)	7 (2)	7 (2)	7 (2)	7 (2)
72 octane:					
Oklahoma	6	6	6	6	6
Mid-Western (Group 3 basis)	6	6	6	6	6
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	6	6	6	6	6
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	6	6	6	6	6
63-66 octane:					
Oklahoma	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
Mid-Western (Group 3 basis)	5.625	5.625	5.625	5.625	5.625
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)	5.625 (1)
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.75 (1)	5.75 (1)	5.75 (1)	5.75 (1)	5.75 (1)
60 octane & below:					
Oklahoma	5.25	5.25	5.25	5.25	5.25
Mid-Western (Group 3 basis)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
N. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25	5.2 - 5.25
W. Tex. (For shpt. to Tex. & N. M. dest'ns.)	5.25	5.25	5.25	5.25	5.25
Motor Gasoline, 72 octane (ASTM)					
New York harbor	9.2 - 9.4	9.2 - 9.4	9.2 - 9.4	9.2 - 9.4	9.2 - 9.4
New York harbor, barges	9.1 - 9.3	9.1 - 9.3	9.1 - 9.3	9.1 - 9.3	9.1 - 9.3
Philadelphia district	9.2	9.2	9.2	9.2	9.2
Baltimore district	8.95	8.95	8.95	8.95	8.95
Motor Gasoline:					
Western Penna. Bradford-Warren:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 - 8.95	7.75 - 8.95	7.75 - 8.95	7.75 - 8.95	7.75 - 8.95
Western Penna. Other Districts:					
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 - 8.45	7.75 - 8.45	7.75 - 8.45	7.75 - 8.45	7.75 - 8.45

OIL PRICE SECTION ★ At Refineries and Terminals and by Tank Wagon

Prices herewith are reproduced from Platt's *OILGRAM* Daily Oil Price Service, associated with National Petroleum News, whose representatives in all NPN-OILGRAM offices devote their time exclusively to reporting oil industry prices everywhere.

Prices shown are actual sales prices, or quotations meaning sellers' general offers or posted prices; for current sales and shipment; for the business day or period stated; except Tank Wagon prices, prices are for bulk lots such as tank car and motor transport; barge or tanker cargo lot prices are identified; FOB refineries or terminals; in cents per gal. except where shown in bbls. of 42 gals.; ex all fees and taxes; for crude oil and its products lawfully produced and transported; reported as received by *OILGRAM* and National Petroleum News but not guaranteed; for subscribers' private use only and not for resale or distribution or publication. For further details of price conditions apply to any *NPN-OILGRAM* office or see back of any *OILGRAM* Price Service invoice.

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Refinery Prices

Gasoline —U. S. Motor (A S T M) except where otherwise specified

Prices in Effect	July 3	June 26
OKLAHOMA		
76 oct. Ethyl...	6.75	6.75
72 oct.....	6	6
63-66 oct.....	5.625(1)	5.625 (1)
60 oct. & below..	5.25	5.25
60-62, 400 e.p...	5.25 (1)	5.25 (1)
MID-WESTERN (Group 3 basis)		
76 oct. Ethyl...	6.75 – 7.25	6.75 – 7.25
72 oct.....	6	6
63-66 oct.....	5.625	5.625
60 oct. & below..	5.2 – 5.25	5.2 – 5.25
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl...	7	7
72 oct.....	6	6
63-66 oct.....	5.625 (1)	5.625 (1)
60 oct. & below..	5.2 – 5.25	5.2 – 5.25
60-62, 400 e.p...	5.375 (1)	5.375 (1)
W. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
76 oct. Ethyl...	7 (2)	7 (2)
72 oct.....	6	6
63-66 oct.....	5.75 (1)	5.75 (1)
60 oct. & below..	5.25	5.25
CENT. W. TEX. (Prices to truck transports)		
76 oct.....	7 (2)	7 (2)
72 oct.....	6 (2)	6 (2)
67-69 oct.....	....	....
62 oct & below..	5.25 (2)	5.25 (2)
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
60 oct. & below..	No Price	No Price
60-62, 400 e.p...	No Price	No Price
KANSAS (For Kansas destinations only)		
76 oct. Ethyl...	7.25 – 7.5	7.25 – 7.5
72 oct.....	6.25 – 6.3	6.25 – 6.3
63-66 oct.....	5.9 (2)	5.9 (2)
60 oct. & below.	5.5	5.5
ARK. (For shipment to Ark. & La.)		
76 oct. Ethyl...	7 (1)	7 (1)
72 oct., leaded..	6 (1)	6 (1)
70-72 oct. "	5.875 (1)	5.875 (1)
62 oct. "	....	....
60 oct. & below, leaded.....	5.25 (1)	5.25 (1)
WESTERN PENNA. (Motor gasoline)		
Bradford-Warren:		
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 – 8.95	7.75 – 8.95
Other districts:		
"Q" Gasoline, Min. 70 Oct. (ASTM)	7.75 – 8.45	7.75 – 8.45

Prices in Effect	July 3	June 26
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
U.S. Motor: (Oct. ASTM):		
72 oct.....	8 – 8.5	8 – 8.5
67-69 oct.....	....	....
Str. run gasoline, excluding Detroit shpt.....	6	6
OHIO (S. O. Ohio quotations for statewide delivery and subject to exceptions for local price disturbances).		
72 oct.....	8.375	8.375
CALIFORNIA U.S. Motor:		
76 oct. (Ethyl)....	7.5 – 8.75	7.5 – 8.75
70-72 oct. (regular)	6.5 – 7.75	6.5 – 7.75
65 oct. & below (3rd grade).....	6.5 – 6.75	6.5 – 6.75

Kerosine, & Gas Fuel Oils

OKLAHOMA		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5	4.5
Range Oil.....	4	4
No. 1 P.W.....	3.875	3.875
No. 1 straw.....	....	....
No. 2 straw.....	3.625	3.625
No. 3 fuel.....	3.5 (2)	3.5 (2)
U. G. I. Gas Oil...	....	....
No. 6 fuel.....	....	....
14-16 fuel.....	$0.97 (2)	$0.97 (2)
MID-WESTERN (Group 3 basis)		
41-43 grav. w.w...	4.375	4.375
42-44 grav. w.w...	4.5	4.5
Range Oil.....	4 – 4.1 (2)	4 – 4.1(2)
No. 1 p.w.....	3.875	3.875
No. 2 straw.....	3.625	3.625
No. 3.....	....	....
No. 5.....	....	....
No. 6.....	$0.80 (1)	$0.80 (1)
N. TEX. (For shpt. to Tex. & N. M. dest'ns.)		
41-43 grav. w.w....	4.375	4.375
42-44 grav. w.w....	4.5 (1)	4.5 (1)
No. 1 P.W.....	3.875 (1)	3.875 (1)
AMARILLO, TEX. (For shpt. to W. Okla. & Tex. differential territory.)		
42-44 grav. w.w...	4.5 (1)	4.5 (1)
No. 1 straw.....	No Price	No Price
KANSAS (For Kansas destinations only).		
41-43 grav. w.w...	No Price	No Price
42-44 grav. w.w...	4.7 – 4.75	4.7 – 4.75
No. 1 p.w.....	4.1	4.1
No. 6 fuel.....	$0.85	$0.85
ARK. (For shipment to Ark. and La.)		
41-43 grav. w.w...	....	....
42-44 w.w. kero...	4.5 (1)	4.5 (1)
No. 1.....	4 (1)	4 (1)
No. 2.....	3.625 (1)	3.625 (1)
No. 3 fuel.....	3.5 (1)	3.5 (1)
Tractor fuel, for shpt. to Ark. points only....	5.125 (1)	5.125 (1)
Diesel fuel 52 & below.....	4 (1)	4 (1)
Diesel fuel 50 & above.....	4.25 (1)	4.25 (1)
WESTERN PENNA.		
Bradford-Warren:		
45 grav. w.w.....	6.55 – 8.05	6.55 – 8.05
46 grav. w.w.....	6.675 (1)	6.675 (1)
No. 1 fuel.....	6.55-8.05 (b)	6.55–8.05(b)
No. 2 "	6.125–7.625(b)	6.125–7.625(b)
No. 3 " ....6.25–7.75 (1&b)		6.25–7.75(1&b)
36-40 gravity...	6.625–6.75 (2)	6.625–6.75(2)

(b) Highs and lows for Schedule D area; in RPS 88 and outside Schedule D area, respectively.

Other districts:		
45 grav. w.w.....	7.25 – 7.925	7.25 – 7.925
46 grav. w.w.....	7.25 – 7.625	7.25 – 7.625
47 grav. w.w.....	7.375– 7.875	7.375– 7.875
No. 1 fuel.....	6.875– 7.375	6.875– 7.375
No. 2 "	6.75 – 7.375	6.75 – 7.375
No. 3 "	6.75 – 7.375	6.75 – 7.375
36-40 grav. Pittsburgh dist. prices excluded.....	6.625– 7.375	6.625– 7 375
CENTRAL MICHIGAN (FOB Central Mich. refinery group basis for shpt. within Mich.; shpts. may originate at plants outside Central group.)		
47-49 gravity w.w.	5.8 – 6	5.8 – 6
P.W. Distillate...	5.5	5.5
No. 3 gas oil, Straw	5	5
U.G.I. gas oil.....	4.5 (2)	4.5 (2)
Fuel Oils (*Vis. at* 100).		
300-500 Vis....	....	....
100-300 Vis....	4.5	4.5
OHIO (S. O. quotations for statewide delivery)		
Kerosine.....	7	7
CALIFORNIA		
40-43 grav. w.w...	5 – 7	5 – 7
San Joaquin Valley:		
Heavy fuel.....	$1.10 (2)	$1.10 (2)
Light fuel.....	$1.20 (2)	$1.20 (2)
Diesel fuel.....	4 (2)	4 (2)
Stove dist.....	5 (2)	5 (2)
Los Angeles:		
Heavy fuel.....	$1.10 (2)	$1.10 (2)
Light fuel.....	$1.20(2)	$1.20 (2)
Diesel fuel.....	4 (2)	4 (2)
Stove dist.....	5 (1)	5 (1)
San Francisco:		
Heavy fuel.....	$1.15 (1)	$1.15 (1)
Light fuel.....	$1.25 (1)	$1.25 (1)
Diesel fuel.....	4.5 (1)	4.5(1)
Stove dist.....	5.5 (1)	5.5(1)

NOTE: All above heavy fuels meet Pacific specification 400; light fuel, spec. 300; Diesel fuels, spec. 200; and stove distillate, spec. 100.

Lubricating Oils

Prices in Effect	July 3	June 26
WESTERN PENNA.		
Prices are for sales made, or offers reliably reported, to jobbers & compounders only.		
Viscous Neutrals—*No. 3 col. Vis. at* 70°*F.* 208 Vis. (180 at 100°) 420-425 fl.		
0 p.t.....	38 (1)	38 (1)
10 p.t.....	37 (1)	37 (1)
15 p.t.....	36 (1)	36 (1)
25 p.t.....	28–33	28–33
150 Vis. (143 at 100°) 400-405 fl.		
0 p.t.....	36 (1)	36 (1)
10 p.t.....	35 (1)	35 (1)
15 p.t.....	34 (1)	34 (1)
25 p.t.....	26–31	26–31

NOTE: Limited quantity neutrals available to regular trade.

Cylinder Stocks

Brt. stk., 145-155 *vis. at* 210°, 540-550 fl., *No. 8 col.*

10 p.t.....	30.5 (1)	30.5 (1)
15 p.t.....	29.5 (1)	29.5 (1)
25 p.t.....	25	25
600 S.R. filterable.	15	15
650 S.R.....	15.5	15.5
600 fl.....	16	16
630 fl.....	17	17

MID-CONTINENT (F. o. b. Tulsa)

Neutral Oils (*Vis. at* 100° *F. 0 to* 10 *P.P.*)

Pale Oils:

Vis. Color		
60-85—No. 2....	7.5	7.5
86-110—No. 2...	7.5 – 8.5	7.5– 8.5
150—No. 3.....	11 –11.5	11 –11.5
180—No. 3.....	11.5 –15	11.5–15
200—No. 3.....	12 –15	12 –15
250—No. 3.....	14 –16.5	14 –16.5
280—No. 3.....	15 –17	15 –17
300—No. 3.....	16 –18	16 –18

Red Oils:

180—No. 5.....	11.5 (1)	11.5 (1)
200—No. 5.....	12	12
280—No. 5.....	No Price	No Price
300—No. 5.....	16-17.5 (2)	16–17.5(2)

NOTE: Discounts of 0.5c to 1c on bright stock and 0.5c to 2c allowed for neutrals on contracts, 10 car lots, and to "meet competition." Brokers offering at greater discounts.

Bright Stock—*Vis. at* 210°		
200 Vis. D.....	27 (1)	27 (1)
150-160 Vis. D:		
0 to 10 p.p.....	23	23
10 to 25 p.p.....	22.5–23	22.5-23
25 to 40 p.p.....	23 (1)	23 (1)
150-160 Vis. E....	22 (1)	22 (1)
120 Vis. D:		
0 to 10 p.p.....	22 (2)	22 (2)
600 S.R. Dark Green.....	8.5 (1)	8.5 (1)
600 S.R. Olive Green.....	10–11 (2)	10–11 (2)
631 S.R.....	....	....
Black Oil.....	....	5.5 (1)

NOTE—Discounts of 0.5c to 2c off for contracts to "meet competition". Brokers offerings at greater discounts.

SOUTH TEXAS Neutral Oils

Pale Oils (*Vis. at* 100°*F.*)

Vis. Color		
100 No. 1½-2½.	6.5	6.5
200 No. 2-3.....	8.75	8.75
300 No. 2-3.....	9.25	9.25
500 No. 2½-3½.	10	10
750 No. 3-4.....	10.25	10.25
1200 No. 3-4.....	10.375	10.375
2000 No. 4.....	10.5	10.5

(Continued on next page)

NOTE—Parenthetical figures after prices indicate number of companies quoting when less than three companies are quoting.

NOTICE—Owing to great demand, refiners generally limit quotations to regular customers and refuse bids, though higher, from others. Refiners' prices and sales shown; bids reported in market leads.

Refinery Prices (Continued)

Prices in Effect	July 3	June 26
Red Oils:		
100 No. 5-6	6.5 (2)	6.5 (2)
200 No. 5-6	8.75	8.75
300 No. 5-6	9.25	9.25
500 No. 5-6	10	10
750 No. 5-6	10.25	10.25
1200 No. 5-6	10.375	10.375
2000 No. 5-6	10.5	10.5

CHICAGO (From Mid-Continent p.l. crude.)
Neutral oils *vis. at* 100° *F. to* 10 *p. p.*

Pale Oils		
Vis. Color		
60-85—No. 2	9 (1)	9 (1)
86-110—No. 2	9.25 (1)	9.25 (1)
150—No. 3	12.5 (1)	12.5 (1)
180—No. 3	13 (1)	13 (1)
200—No. 3	13 (1)	13 (1)
250—No. 3	14 (1)	14 (1)
Red Oils:		
180—No. 5	13 (1)	13 (1)
200—No. 5	13 (1)	13 (1)
250—No. 5	14 (1)	14 (1)
280—No. 5	15 (1)	15 (1)
300—No. 5	15.5 (1)	15.5 (1)

Note: Viscous oils, 15 to 30 p.p. are quoted 0.5c lower; 60-85 and 86-110 No. 2 non-viscous oils, 15 to 30 p.p., 0.25c lower.

Unfiltered Steam Refined: (*Viscosity at* 210°)		
140	11.5 (1)	11.5 (1)
160	12.5 (1)	12.5 (1)
200	13.5 (1)	13.5 (1)
Bright stocks, 160 *vis. at* 210 *No.* 8 *color:*		
0 to 10 p.p.	24 (1)	24 (1)
15 to 25 p.p.	23.5 (1)	23.5 (1)
30 to 40 p.p.	21.5 (1)	21.5 (1)
E filtered Cyl. Stock	15.5 (1)	15.5 (1)

Note: To obtain prices delivered in Chicago, add 0.25c per gal.

Natural Gasoline

(Group 3 & Breckenridge prices are to blenders on freight basis shown below. Shipments may originate in any Mid-Continent manufacturing district.)

FOB GROUP 3		
Grade 26-70	4.75 (Quote)	4.75 (Quote)
FOB BRECKENRIDGE		
Grade 26-70	4.375 (Quote)	4.375 (Quote)
CALIFORNIA (FOB plants in Los Angeles basin)		
21 pound vapor pressure for blending	4.75 - 5.375	4.75 - 5.375

Naphtha and Solvent

(*FOB Group* 3)		
Stoddard solvent	6.625	6.625
Cleaners' naphtha	7.125	7.125
V.M.&P. naphtha	7.1 - 7.125	7.1 - 7.125
Mineral spirits	6.1 - 6.125	6.1 - 6.125
Rubber solvent	7.1 - 7.125	7.1 - 7.125
Lacquer diluent	7.375- 8.125	7.375- 8.125
Benzol Diluent	7.875- 8.625	7.875- 8.625
WESTERN PENNA.		
Bradford-Warren District:		
Stoddard Solvent	7.5 (1)	7.5 (1)
Other Districts:		
Untreated naphtha	7 - 7.25(2)	7 (2)
Stoddard solvent	7.25 - 7.5(2)	7.25 - 7.5(2)

OHIO (S. O. quotations for statewide delivery): V.M.&P. naphtha, D.C. naphtha, Varnolene &

Sohio solvent	10	10
Rubber solvent	9	9

Wax

WESTERN PENNA. (Bbls. C.L.)

White Crude Scale:		
122-124 A.m.p.	4.25 (2)	4.25 (2)
124-126 A.m.p.	4.25	4.25

OKLAHOMA (C.L. FOB Refinery)

Semi-refined:		
128 AMP min., white, 50 kilo bags	No Price	No Price
132-134 AMP, bbls.	5.25 (1)	5.25 (1)

CHICAGO (FOB Chicago district refinery of one refiner, in bags, carloads. Carloads, slabs loose 0.4c less. Melting points are EMP (ASTM) methods; add 3° to convert into AMP.)

Fully refined:		
122-124 (bags only)	5.6	5.6
125-127	6	6
127-129	6.25	6.25
130-132	6.55	6.55
132-134	6.8	6.8
135-137	7.55	7.55

Petrolatums

WESTERN PENNA. (Bbls., carloads; tank cars 0.5c per lb. less.)

Snow White	6.125- 7.25	6.125- 7.25
Lily White	5.375- 6.25	5.375- 6.25
Cream White	4.375- 5.5	4.375- 5.5
Light Amber	3.375- 4	3.375- 4
Amber	3.125- 3.75	3.125- 3.75
Red	3 - 3.5	3 - 3.5

Tank Wagon Prices

Commercial or consumer tank car, tank wagon, dealer, and service station prices for gasoline **do not include** *taxes; they do, however, include inspection fees as shown in general footnote. Gasoline taxes, shown in separate column, include 1.5c federal, and state taxes; also city and county taxes as indicated in footnotes. Kerosine tank wagon prices also do not include taxes; kerosine taxes where levied are indicated in footnotes. Dealer discounts are shown in footnotes. These prices in effect July 3, 1944 as posted by principal marketing companies at their headquarters offices, but subject to later correction.*

S. O. N. J.

Esso (*Regular Grade*)	Consumer Tank Wagon	Dealer T.W.	Gaso-line Taxes	Kero-sine T.W.
*Atlantic City, N. J.	10.2	10.7	4.5	10
*Newark, N. J.	10.2	10.7	4.5	10
Annapolis, Md.	10.55	11.05	5.5	....
Baltimore, Md.	9.95	10.45	5.5	10.8
Cumberland, Md.	11.35	11.85	5.5	12.3
Washington, D. C.	10.2	10.7	4.5	11.3
Danville, Va.	11.65	12.15	6.5	12.55
Norfolk, Va.	10.45	10.95	6.5	12.3
Petersburg, Va.	10.75	11.25	6.5	13.3
Richmond, Va.	10.75	11.25	6.5	13.3
Roanoke, Va.	11.95	12.45	6.5	12.8
Charleston, W. Va.	12.25	12.75	6.5	13.6
Parkersburg, W. Va.	11.55	12.05	6.5	13.3
Wheeling, W. Va.	11.55	12.05	6.5	13.9
Charlotte, N. C.	12.1	12.6	7.5	11.6
Hickory, N. C.	12.65	13.15	7.5	12.6
Mt. Airy, N. C.	12.5	13.0	7.5	11.8
Raleigh, N. C.	11.85	12.35	7.5	12.6
Salisbury, N. C.	12.15	12.65	7.5	13.0
Charleston, S. C.	10.95	11.45	7.5	....
Columbia, S. C.	11.8	12.3	7.5	....
Spartanburg, S. C.	12.5	13.0	7.5	....

	Mineral Spirits T.W.	V.M.&P. T.W.
Newark, N. J.	13	14.5
Baltimore, Md.	15.5	....
Washington, D. C.	15.5	....

Fuel Oils—T.W.	No. 1	No. 2	No. 3
Atlantic City, N. J.	10	9	9
Newark	10	9	9
Annapolis, Md.	....	....	....
Baltimore	9.8	9	9
Washington, D. C.	10.3	9.4	9.4
Norfolk, Va.	10	8.8	8.8
Petersburg	10.3	9	....
Richmond	10.3	9	9
Charlotte, N. C.	10.6	10.4	....
Hickory, N. C.	....	10	....
Raleigh	11.6	10.1	....
Charleston, S. C.	....	9	....
Columbia	....	10	....
Spartanburg	....	10.8	....

*Effective Aug. 5, '42 minimum retail resale price of 14.2c posted thru New Jersey.

Discounts:

Esso gasoline—to undivided dealers, 0.5c off dealer t.w.

Kerosine—1c off t.w. price for 25 gals. or more, under contract thru territory (Baltimore city contract not necessary) except no discount in state of New Jersey.

Naphthas—To buyers taking following quantities at one time: Newark, 2c per gal. on 200 gals. or more, less than 200 gals. 0.5c higher price; Baltimore, 2c off on 25 to 100 gals. and 3c on over 100 gals.; Washington, 2c off to contract buyers.

(N.B. Prices are Continental's "structural" prices. Prices do not reflect temporary reductions made to meet local competition.)

Notice

These prices include inspection fees on both gasoline and kerosine unless otherwise specified per gallon as follows:

Ala. 1/40c on gasoline, 1/2c on kerosine; Ark. 1/20c; Fl. 1/8c; Ill. 3/100c; Ind. 1/5c in lots of 25 bbls. or less, 2/25c in lots of more than 25 bbls.; Kans. 1/50c; La. 1/32c; Minn. 7/200c; Mis. 1/50c; Neb. 3/100c; Nev. gasoline 1/20c; N. C. 1/4c; N. Da. 1/20c; Okla. 2/25c; S. Car. 1/8c; S. Da. 1/20c; Tenn. 2/5c: and Wisc. 3/100c.

Kerosine inspection fees only: Iowa 3/50c; Mich. 1/5c per gal.

CONT'L OIL

	Conoco Bronz-e-z (*Reg*) †Tank	Demand (*3rd Grade*) Wagon	Gaso-line Taxes	Kero-sine T.W.
Denver, Col.	11	10	5.5	11
Grand Junc., Col.	12.5	11.5	5.5	12.5
Pueblo, Col.	10.5	9.5	5.5	10.5
Casper, Wyo.	11.5	10.5	5.5	12
Cheyenne, Wyo.	11	10	5.5	11.5
Billings, Mont.	12.5	11.5	6.5	12.5
Butte, Mont.	13.5	12.5	6.5	13.5
Great Falls, Mont.	12.5	11.5	6.5	12.5
Helena, Mont.	13	12	6.5	13
Salt Lake City, Utah	13.5	12.5	5.5	14.5
Boise, Ida.	14.1	13.1	6.5	16.5
Twin Falls, Ida.	15.6	14.6	6.5	17
Albuquerque, N. M.	10	9	*7	9.5
Roswell, N. M.	9.5	8.5	*7	9
Santa Fe, N. M.	10.5	9.5	*7.5	10
Ft. Smith, Ark.	9.5	9.25	*7	9.5
Texarkana, Ark.	9	8	*5.5	9
Muskogee, Okla.	9.5	8.5	7	8.5
Oklahoma City, Okla.	9.5	8.5	7	8.5
Tulsa, Okla.	9.5	8.5	7	8.5

*Taxes: In gasoline tax column are included these city taxes—Albuquerque, & Roswell, 0.5c, Santa Fe, 1c. Texas 4c state tax applies within city limits of Texarkana, Ark.; Okla. 5.5c state applies within city limits of Ft. Smith, Ark.

†To consumers & Dealers.

S. O. NEB.

(*Regular Grade*)	T.W.	Dealer	Gaso-line Taxes	Kero-sine T.W.
Omaha	11.4	9.6	6.5	10.1
McCook	12.0	10.1	6.5	10.5
Norfolk	11.9	10.4	6.5	10.6
North Platte	12.2	10.6	6.5	11
Scottsbluff	12.9	10.2	6.5	10.8

Standard Gasoline (*Regular Grade*)
Flight Gasoline (*Third Grade*)

S. O. CAL.

	Standard Posted Net Tank Truck	Standard Posted Re-tail	Flight Posted Net Tank Truck	Flight Posted Re-tail	Gaso-line Taxes
San Francisco, Cal.	10	14	9	12	4.5
Los Angeles, Cal.	9.5	13.5	8.5	11.5	4.5
Fresno, Cal.	11	15	10	13	4.5
Phoenix, Ariz.	12	16	10	13	6.5
Reno, Nev.	12	16	11	14	5.5
Portland, Ore.	10.5	14.5	9.5	12.5	6.5
Seattle, Wash.	10.5	14.5	9.5	12.5	6.5
Spokane, Wash.	12.5	16.5	11.5	14.5	6.5
Tacoma, Wash.	10.5	14.5	9.5	12.5	6.5

Std. Aviation 73

	Posted Net Tank Truck	Gasoline Taxes	Kerosine Tank Truck
San Francisco, Cal.	12.5	4.5	11.5
Los Angeles, Cal.	12	4.5	10
Fresno, Cal.	13.5	4.5	12.5
Phoenix, Ariz.	14.5	6.5	12.5
Reno, Nev.	14.5	5.5	13.5
Portland, Ore.	13	6.5	13.8
Seattle, Wash.	13	6.5	13.8
Spokane, Wash.	16	6.5	16.8
Tacoma, Wash.	13	6.5	13.8

Resale & Commercial: T.C. deliveries 0.25c per gal. off posted net tank truck.

Commercial: Retail deliveries, and/or tank truck deliveries of less than 40 gals., 4c per gal. above posted net tank truck price for Standard Aviation and Standard Gasoline, and 3c per gal. above posted net tank truck for Flight Gasoline, except single deliveries of less than 40 gals. to Marine trade only, which are billed at posted net tank truck price.

TEXAS CO.

	Gasoline—Dealer T.W. Fire-Chief (*Regular*)	Indian (*3rd Grade*)	Gaso-line Taxes
Dallas, Tex.	7.5	6.5	5.5
Ft. Worth, Tex.	7.5	6.5	5.5
Wichita Falls, Tex.	8.5	7.5	5.5
Amarillo, Tex.	8.5	7.5	5.5
Tyler, Tex.	8.5	7.5	5.5
El Paso, Tex.	11	10.5	5.5
San Angelo, Tex.	8.5	7.5	5.5
Waco, Tex.	8.5*	7*	5.5
Austin, Tex.	8.5	7.5	5.5
Houston, Tex.	8.5	7.5	5.5
San Antonio, Tex.	8.5	7.5	5.5
Port Arthur, Tex.	8.5	7.5	5.5

*Less 1c temporary allowance to all dealers.

(Continued on next page)

Tank Wagon Prices—Continued

S. O. IND.

Red Crown (*Regular Grade*)
Blue Crown (*Third Grade*)

Red Dealer Prices	Crown Cons. T.W.	Red Crown	Blue Crown	Gaso-line Taxes	Kero-sine T.W.
Chicago, Ill.	11.6	9.6	9.1	4.5	10.6
Decatur, Ill.	11.6	9.6	8.7	4.5	10.3
Joliet, Ill.	11.9	10.3	9.2	4.5	10.6
Peoria, Ill.	11.7	9.9	9.7	4.5	10.4
Indianapolis, Ind.	11.6	10.1	9.6	5.5	10.1
Evansville, Ind.	11.4	9.9	8.6	5.5	9.9
South Bend, Ind.	12	10.5	10	5.5	10.5
Detroit, Mich.	11.4	9.9	9.4	4.5	10
Grand Rapids, Mich.	11.4	9.9	9.4	4.5	9.9
Saginaw, Mich.	11.4	9.9	9.4	4.5	9.9
Green Bay, Wis.	12.2	10.7	10.2	5.5	10.9
Milwaukee, Wis.	12.1	10.6	10.1	5.5	10.8
La Crosse, Wis.	11.9	10.4	9.9	5.5	10.6
Minneapolis - St. Paul.	11.9	10.4	9.9	5.5	10.6
Duluth, Minn.	12.2	10.7	10.2	5.5	10.9
Mankato, Minn.	11.9	10.4	9.9	5.5	10.6
Des Moines, Ia.	11.4	9.9	9.4	4.5	*10.1
Mason City, Ia.	11.7	10.2	9.7	4.5	*10.4
St. Louis, Mo.	11.0	9.5	9.3	*4.5	10.1
Kansas City, Mo.	11.0	9.5	8.6	*4.5	9.7
St. Joseph, Mo.	11.2	9.7	9.2	*4.5	9.9
Fargo, N. D.	12.9	11.4	10.9	5.5	11.6
Huron, S. D.	12.3	10.8	10.3	5.5	11
Wichita, Kans.	10.3	8.8	7.2	4.5	9.0

Stanavo Aviation 73 Octane
Withdrawn Jan. 1, 1944.

(Prices are base prices before discounts)	Oleum Spirits	V.M.&P. Naphtha	Stani-sol	*Taxes
Chicago	13.5	13.8	12.8	4.5
Detroit	15.8	15	16.3	4.5
K. C., Mo.	13.3	14.3	13.8	1.5
St. Louis, Mo.	13.7	14.7	13.2	1.5
Milwaukee	14.4	15.4	14.9	5.5
Minneap'ls	14.2	15.2	13.5	5.5

Fuel Oils T.W.
Chicago

Standard Heater Oil	
1-99 gals.	9.3
100-149 gals.	8.3
150 gals. & over	7.8

Stanolex Furnace Oil	
1-99 gals.	8.8
100-149 gals.	7.8
150-399 gals.	7.8
400 gals. & over	7.3

Stanolex Fuel A	
1-749 gals.	6.5
750 gals. & over	5.75

Stanolex Fuel C	
1-749 gals.	6.0
750 gals. & over	5.25

Other Points Indianapolis	Stanolex Furnace Oil
1-99 gals.	9.0
100 gals. & over	8.0
Detroit	
1-99 gals.	8.7
100 gals. & over	7.7
Milwaukee	
1-99 gals.	9.0
100 gals. & over	8.0
Minneapolis	
1-99 gals.	9.1
100 gals & over	8.1
St. Louis	
1-99 gals.	8.4
100 gals. & over	7.4
Kansas City	
1-99 gals.	8.1
100 gals. & over	7.1

*Taxes: In gasoline tax column are included these city taxes—Kansas City, St. Joseph and St. Louis, 1c. Iowa kerosine prices are ex 3c state tax. In naphtha tax column are included 1.5c federal tax and state taxes.

State sales, occupation, consumer and use taxes to be added when applicable.

HUMBLE OIL

Humble Motor Fuel (*Regular Grade*)

	Thriftane Humble *Tank Wagon	Re-tail	(*Third Grade*) Thriftane *Tank Wagon	Re-tail	Gaso-line Taxes
Dallas, Tex.	7.5	10.5	6.5	10.5	5.5
Ft. Worth, Tex	6.5	9.5	6	7.5	5.5
Houston, Tex.	8.5	12.5	7.5	10.5	5.5
San Ant., Tex.	8.5	12.5	7.5	10.5	5.5

Kerosine	*Tank Wagon	Retail
Dallas, Tex.	7	10
Ft. Worth, Tex.	7	11
Houston, Tex.	8	11
San Antonio, Tex.	7	10

73 Oct. Aviation Gasoline	Tank Car
FOB Baytown, Tex.	8.5

*To all classes of dealers & consumers.

Fuel oils—Statewide prices are for t.w. & drum deliveries of 50 gals. or more; prices for deliveries of less than 50 gals. are 0.5c higher. Cleveland Division assumed the state-wide fuel oil tank wagon prices on Nos. 1, 2 and 3 fuel oil, effective May 10. However the price of 7.55c per gallon and No. 4 fuel oil (full compartment hose dumps only) will remain as heretofore, in Cleveland Division.

Naphthas—to contract consumers off t.w. prices—Statewide: 300 to 999 gals., 0.5c; 1000 to 2499 gals., 0.75c; 2500 to 4999 gals., 1c; 5000 or more gals., 1.5c. Lucas County: Less than 50 gals., tank wagon price, 50 to 249 gals., 0.5c; 250 to 499 gals., 1c; 500 gals. or over, 1.5c.

S. O. OHIO

*Sohio X-70 Gasoline (*Regular Grade*)

	Consumer T.W.	**Re-sellers	Gaso-line ‡S.S. Taxes	†Kero-sine T.W.
Ohio, Statewide	12	10	13.5	5.5	9.3
Akron	12	9.5	12.5	5.5	9.3
Cincinnati	12	9.5	12.5	5.5	9.3
Cleveland	12	9.5	12.5	5.5	9.3
Columbus	12	9.5	12.5	5.5	9.3
Dayton	12	9.5	12.5	5.5	9.3
Marietta	12	9.5	12.5	5.5	9.3
Portsmouth	12	9.5	12.5	5.5	9.3
Toledo	12	9.5	12.5	5.5	9.3
Youngstown	12	9.5	12.5	5.5	9.3

Aviation Gasoline—Statewide

	Consumer Gasoline T.W.	Taxes
Sohio Aviation Gasoline clear Spec. AN-F-22	14.5	5.5
Esso Ethyl Aviation 73 Oct.	15.5	5.5
Esso Ethyl Aviation 80 Oct.	16.5	5.5
Esso Ethyl Aviation 87 Oct.	17.5	5.5
Esso Ethyl Aviation 91 Oct.	17.5	5.5
Esso Ethyl Aviation 100 Oct.	24.5	5.5

†Naphtha—T.W.	Statewide	Lucas County
S. R. Solvent	13.5	13.5
D. C. Naphtha	14.5	14.25
V.M.&P. Naphtha	14.5	14.25
Varnolene	14.5	14.25
Sohio Solvent	14.5	14.25

Fuel Oils—T.W.	No. 1	No. 2	No. 3	No. 4
Ohio, Statewide	8.3	8.3	7.8	*7.55

*Renown (third-grade) prices are same as X-70 unless otherwise noted.

**Except authorized agents.

†Kerosine prices are ex 1c state tax. Naphtha prices are ex 1.5c federal & 4c state tax.

‡Prices at company-operated stations.

††Statewide prices are subject to exceptions other than those shown.

Discounts:

Esso aviation—on contract to hangar operators and resellers, 2c off consumer t.w.

*For Cleveland area only.

Canada

PRICES OF IMPERIAL OIL, LTD.

Per Imperial Gallon, which is 1.2 U. S. Gallons

IMPERIAL OIL

3-Star Imperial Gasoline (*Regular Grade*)

	†Gasoline T.W.	*Gasoline Taxes	†Kero-sine T.W.
Hamilton, Ont.	17.5	11	18
Toronto, Ont.	17.5	11	18
Brandon, Man.	21	10	23
Winnipeg, Man.	20.5	10	22.5
Regina, Sask.	18	10	20
Saskatoon, Sask.	20.8	10	22.8
Edmonton, Alta.	18.9	10	20.9
Calgary, Alta.	16	10	18
Vancouver, B. C.	15	10	24
Montreal, Que.	17	11	17.5
St. John, N. B.	16.5	13	19
Halifax, N. S.	16.5	13	19

*Includes 3c Federal, and Provincial taxes. To divided & undivided dealers.

Absorption Gasoline—No. 26 R.V.P.—$2.28.

ATLANTIC REFINING

Atlantic White Flash (*Regular Grade*)

	Commercial T.W.	Dealer T.W.	Gaso-line Taxes	Kero-sine T.W.
Philadelphia, Pa.	10.2	10.7	5.5	12.25
Pittsburgh	10.7	11.2	5.5	12.6
Allentown	10.7	11.2	5.5	12.6
Erie	10.7	11.2	5.5	12.6
Scranton	10.7	11.2	5.5	12.6
Altoona	10.7	11.2	5.5	12.6
Emporium	10.7	11.2	5.5	12.6
Indiana	10.7	11.2	5.5	12.6
Uniontown	10.7	11.2	5.5	12.6
Harrisburg	10.7	11.2	5.5	12.6
Williamsport	10.7	11.2	5.5	12.6
Dover, Del.	....	11.2	5.5	12.6
Wilmington, Del.	....	10.7	5.5	12.1
Boston, Mass.	....	10.9	5.5	....
Springfield, Mass.	....	11.8	4.5	....
Worcester, Mass.	....	11.5	4.5	....
Fall River, Mass.	....	11	4.5	....
Hartford, Conn.	....	11.6	4.5	....
New Haven, Conn.	....	11	4.5	....
Providence, R. I.	....	11	4.5	....
Atlantic City, N. J.	....	10.7	4.5	10
Camden, N. J.	....	10.7	4.5	10
Trenton, N. J.	....	10.7	4.5	10
Annapolis, Md.	....	11.05	5.5	10.8
Baltimore, Md.	....	10.45	5.5	9.8
Hagerstown, Md.	....	11.55	5.5	10.3
Richmond, Va.	....	11.25	6.5	12.3
Wilmington, N. C.	....	11.55	7.5	11.9
Brunswick, Ga.	....	10.4	7.5	11.1
Jacksonville, Fla.	....	10.4	8.5	12.1

	Mineral Spirits T.W.†	V.M.&P. T.W.†
Philadelphia, Pa.	11	12.5
Lancaster, Pa.	12	13.5
Pittsburgh, Pa.	12.5	13.5

Fuel Oils—T.W.

	1	2	3	5	6*
Phila., Pa.	10.1	9	9	5.76	5.04*
Allentown, Pa.	10.6	9.3	9.3	....	....
Wilmington, Del.	10.1	9	9	....	....
Springfield, Mass.	10.2	9.4	9.4	....	....
Worcester, Mass.	10.2	9.3	9.3	....	....
Hartford, Conn.	10.5	9.2	9.2	....	....

‡Does not include 1c Georgia kerosine tax.

†Mineral Spirits prices also apply to Stoddard Solvent; V.M.&P. prices also apply to Light Cleaners Naphtha.

Discounts:

Gasoline—to undivided dealers, 0.5c off dealer t.w. except Georgia & Florida dealer t.w. and undivided dealer t.w. prices are same.

Kerosine—Thru Penna. & Delaware, 2c off t.w price on t.w. deliveries of 25 gals. or more at one time.

*Residual fuel 13.0-15.9 gravity effective 10/17/43.

S. O. KY.

Crown Gasoline (*Regular*)
Standard (*Third Grade*)

	†Net Crown	Dealer Standard	Gaso-line Taxes	Kero-sine T.W.
Covington, Ky.	9.5	...	6.5	9.3
Lexington, Ky.	10.5	...	6.5	9.3
Louisville, Ky.	10	...	6.5	8.8
Paducah, Ky.	10	...	6.5	8.8
Jackson, Miss.	10	..	7.5	*9
Vicksburg, Miss.	9.5	...	7.5	*8.5
Birmingham, Ala.	10	...	*8.5	9
Mobile, Ala.	9	...	*9.5	9.5
Montgomery, Ala.	10	...	*9.5	10
Atlanta, Ga.	11.4	...	7.5	*12.1
Augusta, Ga.	11.4	...	7.5	*11.6
Macon, Ga.	11.4	...	7.5	12.1
Savannah, Ga.	10.4	...	7.5	11.1
Jacksonville, Fla.	10.4	...	8.5	10.1
Miami, Fla.	10.4	...	8.5	10.1
Pensacola, Fla.	9	8	*9.5	8
Tampa, Fla.	10.4	...	8.5	10.1

*Taxes: In tax column are included these city and county gasoline taxes: Mobile, 2c city; Birmingham, 1c city; Montgomery, 1c city and 1c county; Pensacola, 1c city. Georgia and Montgomery, Ala. have 1c kerosine tax, Mississippi 0.5c, not included in above prices.

†Consumer t.w. prices are same as net dealer prices.

S. O. LA.

Esso Gasoline (*Regular Grade*)

	Consumer Tank Wagon	Dealer T.W.	Gaso-line Taxes	Kero-sine T.W.
New Orleans, La.	8.75	9.25	8.5	*9
Baton Rouge, La.	8.75	9.25	8.5	*9.5
Alexandria, La.	8.75	9.25	8.5	*9.5
Lafayette, La.	9	9.5	8.5	*9
Lake Charles, La.	9	9.5	8.5	*11
Shreveport, La.	8.5	9	8.5	*8
Knoxville, Tenn.	10.5	11	8.5	12.5
Memphis, Tenn.	8.90	9.40	8.5	10.5
Chattanooga, Tenn.	10.5	11	8.5	11
Nashville, Tenn.	10.5	11	8.5	10
Bristol, Tenn.	10.95	11.45	8.5	13.1
Little Rock, Ark.	9.5	10	8	10

*Louisiana kerosine prices are ex 1c state tax

Discounts:

Esso Gasoline—To undivided dealers, 0.5c off dealer t.w.

(Continued on next page)

Atlantic Coast (Prices are of refiners, FOB their refineries & their tanker terminals, & of tanker terminal operators FOB their terminals)—Prices in Effect July 3.

MOTOR GASOLINE

District	72 Oct. (ASTM)	68-70 Oct. (ASTM)
N. Y. Harb.	9.2 - 9.4	9.2 (1)
N. Y. Harb., barges	9.1 - 9.3	9.1 (1)
Albany	9.3 - 9.4	....
Philadelphia	9.2	....
Baltimore	8.95	8.85 (1)
Norfolk	8.7 - 8.95	8.45 (1)
Wilmington, N. C.	8.7 - 8.75	8.45 (1)
Charleston	8.7 - 8.8	8.1 (1)
Savannah	8.25 - 8.4	....
Jacksonville	8.27 - 8.275	....
Miami	8.27-8.275(2)	....
Tampa	8.27 - 8.4	8.275 (1)
Pensacola	7 - 7.2 (1)	....
Mobile	6.62 - 7.2	....
New Orleans	6.125- 6.375	....
Portland	9.5 - 9.65	....
Boston	9.4	....
Providence	9.4	....

(a) This price is for straight-run low pour test No. 5 fuel.

Pacific Export *In Ship's Bunkers, or deep tank lots:*

Prices in Effect	July 3	June 26
Diesel Fuel, Pac. Spec. 200	$1.45	$1.45
Grade C fuel, Pac. Spec. 400	$1.10	$1.10

Seaboard Export Coastwise Prices

FUEL OILS

	KEROSINE and /or NO. 1 FUEL	No. 2	No. 3	No. 5	No. 6
N. Y. Harbor	7.1	6.7	6.7	$1.95-2.01(1&a)	$1.65 -$2.07
Albany	7	6.6	6.6	....	....
Philadelphia	7.3	6.8	6.8 (2)	....	$1.85-$2.27 (1)
Baltimore	7.2	6.7	6.7	$1.98	$1.65 -$2.07
Norfolk	7.2	6.7	6.7	....	$1.65 -$2.07
Charleston	7.1	6.7	6.7 (1)	....	$1.65-$2.07 (2)
Savannah	7.05	6.7	....	....	....
Jacksonville	7.2	6.7 (2)	....	....	$1.60-$2.02 (2)
Tampa	7.05	6.25 (1)	....	....	$1.60-$2.02 (1)
Miami	7.05 (2)	6.25	....	....	$1.60-$2.02 (1)
Pensacola	7.05	6.25 (1)	....	....	....
Mobile	7.05	6.25	....	....	$1.50-$1.92 (2)
New Orleans	4.8 (1)	....	....	....	....
Portland	4.75 (2)	....	....	....	....
Boston	4.25 - 4.75	3.75 (2)	....	$1.27 (1)	$0.85-$1.27 (2)
Providence	7.3	6.8	6.8 (2)	....	$1.65-$2.07 (1)
	7.2	6.7	6.7 (2)	$1.95-$2.07 (1)	$1.65 -$2.07
	7.2	6.7	6.7 (2)	$1.90 (1)	$1.65 -$2.07

Tank Wagon Prices (Continued)

SOCONY VACUUM

	Socony Mobilgas (*Regular Grade*) Com. Cons. T.W.	Indiv. Dlr. T.W.	Gasoline Taxes
New York City			
Manhattan & Bronx	10.1	10.6	*5.5
Kings & Queens	10.1	10.6	*5.5
Richmond	9.7	10 2	*5.5
Albany, N. Y.	9.9	10.4	5.5
Binghamton, N. Y.	11	11.5	5.5
Buffalo	10.2	10 7	5.5
Jamestown, N. Y.	10.4	10.9	5.5
Mt. Vernon, N. Y.	10.1	10.6	5.5
Plattsburg, N. Y.	11	11.5	5.5
Rochester, N. Y.	10.8	11.3	5.5
Syracuse, N. Y.	10.5	11	5.5
Bridgeport, Conn.	10	10.5	4.5
Danbury, Conn.	10.5	11	4.5
Hartford, Conn.	10.6	11.1	4.5
New Haven, Conn.	10	10.5	4.5
Bangor, Me.	10.7	11.2	5.5
Portland, Me.	10.3	10.8	5.5
Boston, Mass.	9.9	10.4	4.5
Concord, N. H.	11.4	11.9	5.5
Lancaster, N. H.	12	12.5	5.5
Manchester, N. H.	11.3	11.8	5.5
Providence, R. I.	10	10.5	4.5
Burlington, Vt.	10.9	11.4	5.5
Rutland, Vt.	11	11.5	5.5

	Mineral Spirits T.W.	V.M.&P. T.W.
Buffalo, N. Y.	12.4	13.6
New York City	11	12
Rochester, N. Y.	13.2	14.4
Syracuse, N. Y.	14	....
Boston, Mass.	12	13
Bridgeport, Conn.	†16.3	†17.3
Hartford, Conn.	†16.3	†17.3
Providence, R. I.	13	14

	Kerosine Yard	Kerosine T.W.	Mobilfuel Diesel T.C.	Mobilfuel Diesel T.W.	Mobilheat Fuel Yard	Mobilheat Fuel T.W.
New York:						
Manhat'n & Bronx	7.5	10.3	...	9.3	7.1	9
Kings & Queens	7.5	10.3	...	9.3	7.1	9
Richmond	7.5	10.3	...	...	7.1	9.0
Albany	7.5	9.8	7	9.3	7	9
Binghamton	8.9	11.2	...	10.7	8.4	10.2
Buffalo	8.6	10.9	8	10.3	8.2	10
Jamestown	8.7	11	...	10.6	8.3	10
Mt. Vernon	7.6	10.3	...	9.4	7.2	9
Plattsburg	8.1	10.4	...	9.9	7.6	9.4
Rochester	8.7	11	7.9	10.2	7.9	9.7
Syracuse	8.5	10.8	7.8	10.1	7.8	9.6
Conn.:						
Bridgeport	7.8	10.3	...	....	7.4	9.0
Danbury	8.2	10.8	...	....	7.8	8.8
Hartford	8.0	10.5	...	9.5	7.4	9.2
New Haven	7.5	10.3	...	9.3	7.1	9.0
Maine:						
Bangor	7.9	10.2	7.4	9.7	7.4	9.1
Portland	7.5	10.2	7	9.3	7	9
Mass.:						
Boston	7.8	10.6	6.9	9.2	7.1	9
N. H.:						
Concord	8.4	10.7	...	....	8.2	10
Lancaster	9.5	11.8	...	....	9.2	11
Manchester	8.5	11.1	...	....	7.9	9.7
R. I.:						
Providence	7.6	9.9	6.9	9.2	7.1	8.9
Vermont:						
Burlington	8.1	10.4	7.5	9.8	7.5	9.2
Rutland	8.3	10.6	...	10	7.7	9.5

*Does not include 1% city sales tax applicable to price of gasoline (ex tax).

†In steel barrels.

Discounts: Diesel—On t.w. deliveries, 0.5c for at least 400 gals.; 1c for full tank truck.

	Bunker C Fuel Ships' bunkers (Ex Lighterage)	Diesel Oil Ships' bunkers (Ex Lighterage)	Diesel Oil Shore Plants	Gas House Gas Oil 28-34 Gravity
N. Y. Harbor	$1.65 -$2.07	$2.78	6.7-6.8 (2)	6.8 (2)
Albany	$1.85 -$2.09(1)	$2.98 (1)	7 (1)	6.7 (1)
Philadelphia	$1.65 -$2.07	$2.78	....	....
Baltimore	$1.65 -$1.77	$2.78	6.7 (1)	6.7 (1)
Norfolk	$1.65 -$2.07	$2.78	6.7 (1)	6.7 (1)
Charleston	$1.60 -$2.02	$2.78	6.7 (1)	6.7 (1)
Savannah	$1.60-1.72(1)	$2.62 (1)	....	....
Jacksonville	$1.60-$2.02 (2)	$2.62 (2)	....	....
Tampa	$1.50 -$1.92	$2.62	....	....
New Orleans	$0.85-$1.27	$1.65 (1)	4 (1)	....
Portland	$1.65-$1.77	$2.86 (2)	7 (1)	6.9 (1)
Boston	$1.65-$1.77	$2.78	6.7 (2)	6.8 (2)
Providence	$1 65 -$2.07	$2.78 (2)	6.9 (1)	6.8 (1)

Residual fuel prices generally vary with A.P.I. specifications from range low for 9.9 & below degrees to range high for 25.0 & above.

Bunker "C" when from Navy storage at New York and Norfolk to W.A.S. ships .05c discount.

Gulf Coast

Prices in Effect July 3

MOTOR GASOLINE	New Orleans & Lower Mississippi to Baton Rouge Tank Cars	New Orleans & Lower Mississippi to Baton Rouge Barge	Texas Gulf Coast South of New Orleans Tank Cars	Texas Gulf Coast South of New Orleans Barges	CARGOES Domestic & Export From all Gulf Ports
Leaded (oct. by ASTM)					
76 oct.	6.75	6.5 - 6.75	6.5 -6.75	6.75	6.75
72 oct.	6.125-6.375	5.75	5.75-6.5(a)	5.75	5.75
63-65 oct.	....	....	....	....	....
Unleaded 70 oct.	....	....	....	....	5.75
67-68 oct.	....	....	....	....	5.5
65 oct.	....	....	....	....	5.25
60 oct.	....	....	....	....	5
KEROSINE & LIGHT FUELS					
41-43 w.w. kero.	4.125-4.25	4.125	4.125- 4.25	4.125	4.125
42-44 w.w. kero.	....	....	4.125	4.125	4.125
No. 2 fuel oil	3.75	3.75	3.75 - 4	3.75	3.75
DIESEL & GAS OILS					
(In diesel index No.)					
Below 43 di.	....	....	....	....	....
43-47 di.	....	....	....	....	4
48-52 di.	4	4	4	....	4
53-57 di.	4.125	4.125	4.125	4.125	4.125
58 and above	4.25	4.25	4.25	....	4.25

(a) 5.75c for Dist. 1 and 6.5c for other districts.

HEAVY FUELS & BUNKER OILS In Cargoes (At all Gulf Ports) Heavy Diesels	In Ship's Bunkers (Ex-lighterage)
Below 28 API Grav.	$1.35
28 & above API Grav.	$1.65
Bunker C Oil	$0.85-$1.27

Above products in Truck Transports of 2,400 gal. and over ½c above Tank Car Prices.

NOTE—Prices for heavy fuels vary within the range given above according to gravity from 9.9 B grav. and below to 25 B and above.

Mid-Continent Lubes

(At Gulf; in packages, FAS.; in bulk, FOB terminals)

Prices in Effect July 3

	Steel Drums	Bulk
200 Vis. D 210 brt. stock	....	....
150 vis. D 210 brt. stock 0-10 p.p.	32.65(1&A)	24.8 (1)
10-25 p.p.	....	....
100 vis. D 210 brt. stock 0-10 p.p.	....	....
10-25 p.p.	....	....
200 vis. No. 3 col. neutral:		
0-10 p.p.	....	....

(A) FAS at New Orleans

Wax

(Melting points are AMP, 3° higher than EMP. Prices are FOB refinery and do not include bag, freight or export differentials).

Prices In Effect July 3

Crude Scale	New Orleans Export	N. Y. Domestic	N. Y. Export
124-6 Yellow	4.25(1)	....	4.25(1)
122-4 White.	....	4.25(2)	4.25(2)
124-6 White.	4.25(1)	4.25	4.25
Fully Refined:			
123-5	5.2(1)	5.2(2)	5.2(1)
125-7	5.2(1)	5.2(2)	5.2(1)
128-30	5.6(1)	5.6	5.6(1)
130-32	5.85(1)	5.85(2)	5.85(1)
133-5	6.15(1)	6.15	6.15(1)
135-7	6.4(1)	6.4(1)	6.4(1)

Naphtha

Prices in Effect July 3

	V.M.&P. Naphtha	Mineral Spirits
New York Harbor	11 (2)	10
Philadelphia dist.	11 (2)	10
Baltimore	10.5 (2)	9.5
Boston	11.5 (2)	10.5
Providence	11.5 (1)	10.5 (2)

WAR-OIL EQUIPMENT EXCHANGE

If You Can't Use It, Sell It or Scrap It!

For Sale

FOR SALE: 1—2680 gallon 2-compartment Great Dane trailer equipped with meter. Excellent coadition. Tires good. With or without Ford Tractor. Carolina Transfer Co., 405 Pendleton St., Greenville, S. C.

TANKS—MACHINERY
2—10,500 BBL. & 1—2500 BBL. Tanks.
10—8000 Gal. Coiled Tank Cars.
5 Colloid Mills 20, 40 & 100 H.P.
12 Ton Std. Ga. Gas Locomotive.
120 H.P., 240 H.P. & 360 H.P. Diesel Generators.
R. C. STANHOPE, INC.,
60 East 42nd St., New York 17, N. Y.

150 USED STEEL TANKS, open and closed tops, 280 to 1,000,000 gals. 2″ and 3″ Viking pumps. 2″ and 3″ Brodie and other meters. 2″ and 3″ valves, fittings and pipes. All in A-1 condition. Immediate delivery. No. priority.
Empire Equipment Corporation
608 Empire Bldg.
Cleveland 14, Ohio

FOR SALE
1—Chevrolet Truck with 600-gal. 3-compartment Quaker City tank complete with pump, hose, meter and reel. 1—600-gal. (3-compartment) and 1—700-gal. (2-compartment) Quaker City tanks—each with pump, meter and reel.
2000—30-gal. lubsters @ $5.00 ea. (as is).
J. P. Garr, 366 Prospect Ave.,
Hartford 5, Conn.

FOR SALE: 1 Heil Trailerized Tank 3000 gal. capacity. 2 compartment built in pumping unit 2″ and Dodge 2 ton, 1941 Tractor complete offered as complete unit only, or Trailerized tank alone. First class condition.
Quality Gasoline Company
2915 S. Adams St., Marion, Ind.

FOR SALE
1—1936 Studebaker truck with 750-gal. 3-compartment tank complete with pump, hose, meter and reel. Truck and tank in A-1 condition. Priced at $950.00.
McCleary Oil Company,
15-17 W. King St., Chambersburg, Pa.
Phone-659

Situation Open

FOREIGN EMPLOYMENT

The ARABIAN AMERICAN OIL COMPANY is interested in receiving applications from technically trained men with experience in oil field work or in refinery engineering design, construction, or operation, for work in Saudi Arabia. This offers a splendid opportunity for advancement and post war security, with good working conditions, hospital and medical care, liberal benefit plans, and vacation privileges in the United States.

WRITE OR APPLY to our Relations Department, 200 Bush Street, San Francisco 4, California.

Situations Open

Wanted combination electrician and instrument man for independent refinery in Southern Oklahoma. In reply give detailed outline of previous experience, education and draft status. Box No. 413.

Mechanical Draftsman, familiar with designing gasoline and oil storage tanks and refinery equipment. Benson Manufacturing Co., Kansas City 1, Missouri.

WANTED
Operator in compact reclaiming plant. Excellent possibilities for experienced, capable man.
Box No. 411
National Petroleum News

SALES ENGINEER
for independent marketing organization located southeast. Applicant must have experience in lubricating oils, greases and oil specialties. Excellent opportunity for a good producer.
Starting salary $4000.00. In applying state age, education, experience and draft status.
Box No. 408

WANTED
PIPING DRAFTSMAN
Experienced in the design and detailing of pressure piping such as oil refinery, power plant or chemical plant piping High priority war work with independent refinery having long record of full capacity operation and uninterrupted employment. Applicants must comply with War Manpower Commission regulations. Reply—
Box No. 412

DESIGNERS
DRAFTSMEN
AND
SQUAD LEADERS
For Process Piping on Oil Refineries.
Applications solicited from men not now employed in essential work or those completing essential work who have Statements of Availability.
ARTHUR G. McKEE & COMPANY
2300 Chester Avenue
Cleveland, Ohio

Wanted to Buy

WANTED TO BUY: Quantity of 5-Gallon cans with spouts and handles, new or used. Write giving quantity available, products last contained, description and price. Tankar Stations, 432 W. 21st St., Norfolk, Va.

Business Opportunity

MANAGER NEEDED
who may become a partner in an established re-refining plant. Experience in such more necessary than cash. State experience, age, background and present status. Permanency will be up to you.
Box No. 410

Manufacturers Representative

A thoroughly established Manufacturers Representative with unusually broad contacts in the oil refining, chemical and by-product coke plants throughout Western Pennsylvania, Ohio, West Virginia and Kentucky, is seeking an additional account. Now representing two outstanding manufacturers of equipment for above industries. Address Box No. 414.

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ABOUT OIL PEOPLE

Mr. Thompson

E. D. Thompson has been appointed to the newly established post of general manager of dealer sales for the Standard Oil Co. of California, it was announced this week by **E. J. McLanahan**, company vice president. Mr. Thompson will have charge of all company retail business with the exception of company-operated service stations. With Standard since 1916, Mr. Thompson was formerly assistant general sales manager, and for five years was advertising manager. He had also held the sales positions for various West Coast cities, including Fresno, Whittier, Seattle and Oakland. Assisting Mr. Thompson in his new post are **R. N. Aldrich**, development consultant; **F. C. Eachus**, manager, development division, and **W. A. Frazer**, manager, merchandising division.

* * *

R. J. (Chub) Daugherty, superintendent of the public relations department, Cities Service Oil Co. in Bartlesville is recovering from a heart attack suffered early last month.

* * *

Socony-Vacuum Oil Co. announced last week that **A. L. Nickerson** of Boston, the company's New England division manager, had been appointed assistant general manager of eastern marketing with headquarters in New York. Mr. Nickerson has been with the company since 1933. **L. A. Myers**, New England division manager of industrial lubricating sales, has been named to succeed Mr. Nickerson.

* * *

Frank Phillips, member of the advisory committee of the National Victory Garden Institute, and Chairman of Phillips Petroleum Co., has announced the winners in the $700 Victory Garden Essay Contest which is a part of the company's $6600 Victory Garden Contest. Awards ranged from $100 to $25 in War Bonds, and more than 1500 children throughout the U. S. participated.

* * *

Paul Bird, in charge of PAW's information division, has resigned to join the public relations staff of Standard Oil Co. of New Jersey. Mr. Bird, formerly with General Motors Corp., will be succeeded by **Stan Allen**, who was also employed by General Motors Corp. and comes to PAW from the Office of War Information.

* * *

Frank Strelow is the first employe to reach the 50-year mark in the Standard Oil Co. of Indiana's sales department and in celebration of the milepost, Mr. Strelow, who is supervisor of the South Milwaukee bulk plant, received a gold watch from the board of directors. **J. H. Budde**, manager of the Milwaukee sales division, made the presentation. With another two years to go before he reaches 65, the company's retirement age, Mr. Strelow will continue as bulk plant supervisor.

* * *

Offices for the J. R. Sharp Drilling Co. and associated activities have been opened in Midland, Texas, with **Bob Franklin** superintendent of operations and company partner, in charge. The office staff was moved from Tulsa.

* * *

176 Attend Annual Golf Tourney of Chicago Oil Men's Club

Although rain dampened the spirits and golf togs of morning golfers at the Chicago Oil Men's Club party, held at Rolling Green Country Club, June 22, everything turned out all right when the sun came out around noon. Attendance numbered 176, which **M. W. Prellberg** of Jas. B. Berry Sons Co. handled, as chairman of the entertainment committee.

R. P. Baker, Pure Oil Co., left that night the possessor of a set of highball glasses awarded him for scoring low gross. Other winners were: **George B. Williams**, PAW; **Lloyd Dilworth**, Lloyd Direct Service Stations; **Karl F. Holdefer**, Commerce Petroleum; **Roy J. Thompson**, Apex Motor Fuel Co.; **Henry G. Plane**, Johnson Oil Refining; **E. T. McGovern**, Valvoline (Madison); **Jene Harper**, Franklin Supply; **R. G. Satterly**, Arrow Petroleum Co.; **W. C. McCallion**, Allied Oil (Cleveland); **"Tiny" Forsberg**, Geo. N. Olson Co.; **L. Munson**, Calumet Refining; **J. A. Waddell**, **Henry H. Cross**; **C. J. Wood**, and **G. D. Daly**, both of Harry P. Dunn Co.; **J. G. Pyke**, Midwest Refining Co., Grand Rapids; **W. T. Hansen**, Wisconsin Independent Oil Co.; **J. H. Begley**, Pennsylvania Grade Crude Oil Assn.; **Miles R. Wiseman**, Allied Oil; and **H. McGaughey**, W. H. Pugh Oil Co. Attendance award went to **John Gibson** of Automotive Oil Heating Co. and **Paul Nelson**, Cities Service Oil Co.

The best play of the day was made by **M. G. Benedict**, Apex Oil Co., St. Louis, who sunk a 60-foot shot off the fairway.

A number of out-of-town guests attended, among them **J. W. Shemwell**, Atlas Oil Corp., Shreveport, La.

Present at the Chicago Oil Men's Club golf tournament last week were, left to right: Holger Jensen, Jensen Petroleum Co.; J. Brambach, a guest; Wilson Henry, Valvoline Oil Co., and Henry G. Plane, Johnson Oil Refining Co., and club treasurer

C. S. Rosenthal, second from left, of Apex Motor Fuel Co., first president of the Chicago Oil Men's Club also attended the club's annual golf party. Others, left to right, are Roy J. Thompson, Tom Plunkett and John Moll, all of Apex

Mr. Slack

Charles K. Slack, assistant treasurer of the General Petroleum Corp. of California, has been elected president of the Petroleum Accountants Society at Los Angeles, it was announced this week. Other officers for the ensuing year are **S. J. Anderson,** Ring Oil Co. Ltd., first vice president; **Alfred F. Hagen,** Shell Oil Co., Inc., second vice president, and **John P. Vezzetti,** Sunset Oil Co., secretary-treasurer. In addition to the officers, who are also directors, the following were named members of the board of directors: **N. J. Allen,** of R. E. Bering, Operator; **Verne Harrell,** Bankline Oil Co.; **E. E. Rogers,** Union Oil Co. of California; **Paul Stanley,** Barnsdall Oil Co., and **K. D. Vandervort,** Amerada Petroleum Corp.

° ° °

E. O. Derrick, former sales manager for the Cushing Oil and Refining Co., Cushing, Okla., has been named vice president and sales manager for the Mercury Oil Refining Co., at Oklahoma City. He replaces **R. G. Cocanower,** who resigned.

° ° °

D. A. Windsor, St. Louis, for 21 years associated with the Lubrite Division refinery of Socony-Vacuum Oil Co. in East St. Louis, Ill., has resigned as general superintendent to accept the presidency of the Marietta Manufacturing Co., a boat-building concern at Point Pleasant, W. Va. H. T. Ashton, Lubrite Division general manager, gave a dinner in Mr. Windsor's honor just before he left at which a group of his early-day associates at Lubrite were special guests.

° ° °

Vincent T. Gilchrist, comptroller of the Superior Oil Co., Houston, has been elected to membership in the Controllers Institute of America. The institute is a technical and professional organization of controllers devoted to improvement of controllership procedure.

° ° °

New division land man at Fort Worth for the Stanolind Oil and Gas Co. is **J. Guy McMillian** of Midland, Texas, who succeeds **W. G. Lackey,** who has been transferred to Houston as division landman for the Gulf Coast, Texas and Louisiana. Mr. Lackey succeeds **E. H. Stafford,** who has resigned to go into the oil business as an independent.

° ° °

R. J. Geagan, who retired from Sinclair Refining Co. about two years ago had to miss the Chicago Oil Men's Club golf party as was in the hospital recovering from a recent operation.

LAZY BENCH

Success Story

Two fleas fell in love. One lovely June day they were married.

Young, industrious and ambitious, the fleas worked hard and saved their money. They sacrificed fun to assure the future. One day they counted their money and were overjoyed to find they'd saved five dollars.

"If we can save five we can save ten!" they agreed. So they continued their thrift. They toiled, economized and planned, spurning the frivolous pleasures of other fleas. Finally came the day when their savings totaled ten dollars.

That day they went out and bought their own dog.

E. Reitz, Technologist Sec'y.—Ohio

° ° °

G. I. Blues

And there was the soldier who was told that an ounce of a particular kind of ointment would kill ten million fleas. He went to the dispensary and requested the pill roller to issue him two tons.

Gertie of Albuerqukie

° ° °

The tragedy of the flea is that he knows for certain that all of his children will go to the dogs.

—Seabees Coverall, Calif.

° ° °

Now that we have covered the flea front, how about a few dog jokes? Here's one for a starter:

Chess a Dog

Hearing of a dog that could play chess, a man went to the Chess club to see the phenomenon. Sure enough a man and a dog were engrossed in a game of chess. When it was over, the visitor expressed amazement at the dog's intelligence.

"Oh, he's not so smart," said the man. "I can beat him four times out of five."

—PD Banksie, Ohio

° ° °

Horsing Around

A drunk seeing a milk wagon in front of his home early one morning thought he would swipe a bottle. As he reached inside the wagon the horse gruffly said, "Put that back." Startled, he said to the horse, "My heavens, is that you talking?"

"Certainly," replied the horse, "and furthermore I haven't always been pulling a milk wagon. I once won the Kentucky derby."

Just then the driver returned.

"That's the most wonderful and fantastic thing I ever heard of," the drunk told the milk man.

"Pay no attention to him," replied the milk man. "He's a plain fake. I'll bet he's been telling you about winning the derby. That nag has been pulling a milk wagon all his life."

—Em. P., reformed OWI worker

Speaking of horses, there was the little moron who carried a bale of hay to bed to feed his nightmare.

—Bobby D., Sinclair Gal, Mississippi

° ° °

Did you hear the one about the little mouse who ran away from home, because his old man was a rat?

—Texaco J. S., New York City

° ° °

Or the one about the lady who remarked, "I'm pretty sure it was the chimpanzee I sold, but I can't find my husband anywhere."

—A Coryell Gal out West

° ° °

Close Margin

Mama, don't oil men go to heaven?

Of course they do. What makes you ask?

Because I never saw a picture of an angel with a moustache like daddy's.

Oh, that's because oil men get there by such a close shave.

—LST, Ohio.

° ° °

Tragedy

Car
Caress
Careless
Carless

—Marianne, Pa. Rfg. lady.

Oil ladies! Candy for yourself or cigarets for your boy friend in the service for all contributions used. Address Lazybench Editor, 530, Penton Bldg., Cleveland.

English

The odd-job man knocked on the door for his lunch.

"Did you notice that big pile of wood over there", asked the lady.

"Yeah, I seen it."

"Mind your grammar" snapped the lady. "You should say you saw it."

"Lady", he answered "you saw me see it, but you ain't seen me saw it."

—JB, Louisville.

° ° °

Refined

Do you know why the little moron wouldn't talk about oil? He heard it is crude and unrefined!

M.O'B, Tulsa.

Howcum all these little morons are he's. Aren't there any she morons?—Ed.

° ° °

? ? ?

Be she gone,
As she went,
As she left I all alone,
Will she ne'er come back to I?
No! No! It cannot was.

—Mary Huston, PennZoil gal from Penna.

SPEEDS TAKE-OFFS

Boosts Climbing and Bomb-Carrying Power of U. S. Aviation Gasolines!

"FLYING HORSEPOWER"

Coming in Mobilgas after the War—
Same Power Ingredients that are Helping our Fliers win Air Supremacy!

Mobilgas
SOCONY-VACUUM

BACK OF headline news of U.S. victories in the air is great news for Mobilgas jobbers.

After the war, the same power ingredients that make "Flying Horsepower" so effective in airplane engines will go into Mobilgas for cars ...will yield the same quick getaway and power-pull.

"Flying Horsepower" is the result of 11 years of Socony-Vacuum pioneering . . . *the world's greatest Catalytic Cracking Development Program.* Today, 14 huge Socony-Vacuum super-fuel refineries are producing for war. Tomorrow, they'll be ready to help bring Mobilgas jobbers *Mobilgas with "Flying Horsepower"!*

SOCONY-VACUUM OIL CO., INC.

NEW YORK, N.Y.—26 Broadway • CHICAGO, ILLINOIS—59 E.Van Buren Street • MILWAUKEE, WISCONSIN—907 South First Street • CLEVELAND, OHIO—4614 Prospect Avenue • KANSAS CITY, MISSOURI—925 Grand Avenue • DETROIT, MICHIGAN—903 West Grand Boulevard • ST. LOUIS, MISSOURI—4140 Lindell Boulevard • DALLAS, TEXAS—Magnolia Petroleum Company, Magnolia Bldg.

Socony-Vacuum maintains many other conveniently located service offices to give you close and fast cooperation.

LOOK TO *Gilbarco*

FOR THE BEST IN POSTWAR LUBE EQUIPMENT

After Victory there will be more cars than ever before on the highways of America... more cars to lubricate—more profits to be made by doing lubrication work quickly and well. You'll be able to do that work better, faster, more profitably—with *new* Gilbarco lube equipment. Expect the best in that new equipment—for that is just what Gilbarco is planning to produce.

GILBERT & BARKER MFG. CO.

WEST SPRINGFIELD, MASSACHUSETTS • TORONTO, CANADA

TECHNOLOGY DEPT.

NATIONAL PETROLEUM NEWS

Monthly Technical Section Devoted to

REFINERY MANAGEMENT *and* PETROLEUM CHEMICAL TECHNOLOGY

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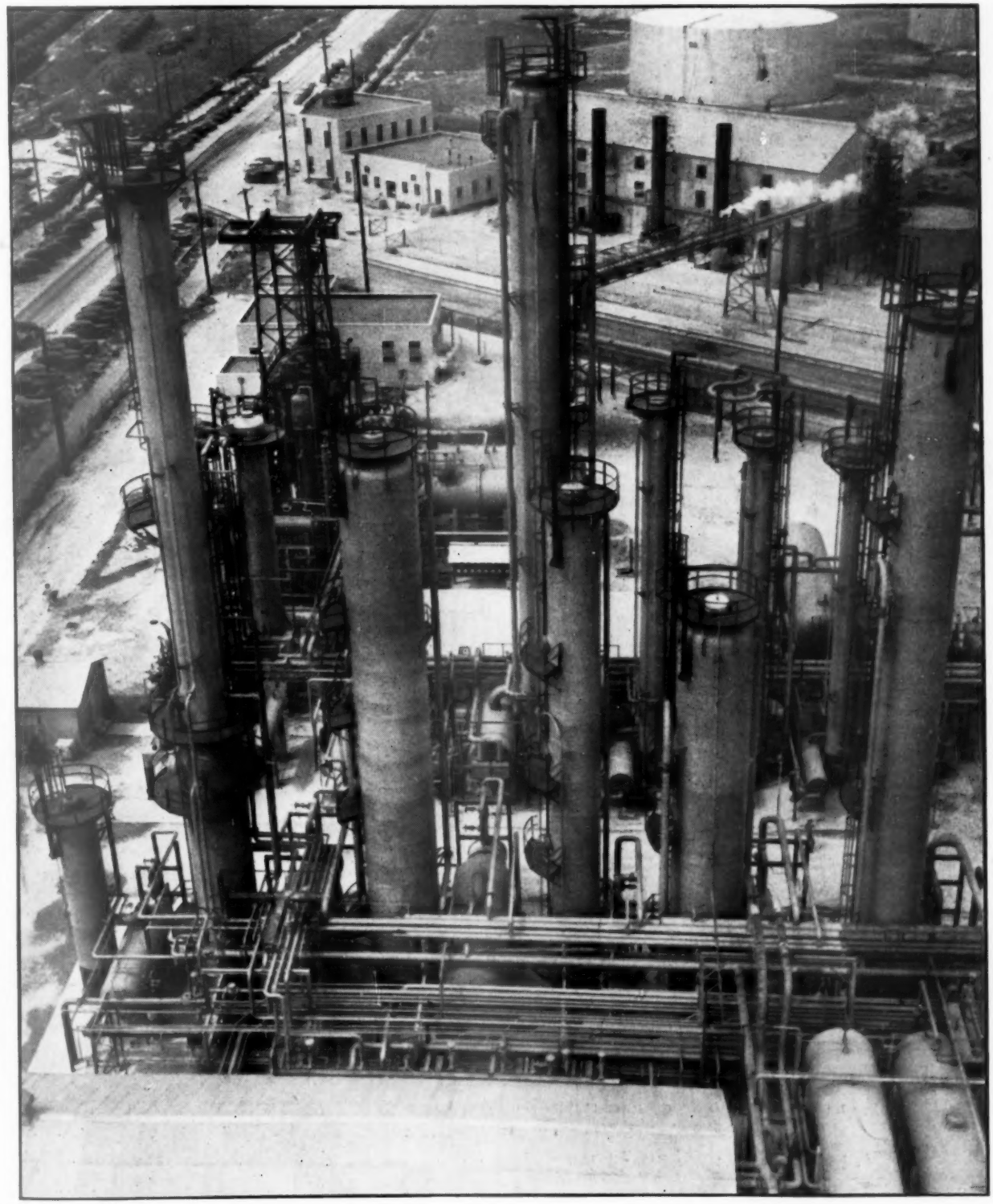
Section Two **Second Anniversary Issue** **July 5, 1944**



AN INDEPENDENT'S 100-OCTANE PLANT—Dedicated to the nation's service June 14 was the 4000-bbl daily capacity aviation gasoline plant of the refinery at Texas City of Republic Oil Refining Co., one of the principal independent oil companies of the country. In the foreground are the fractionator towers in the alkylation and gas concentration unit of the new facilities; left background, office building and laboratory; center background the new boiler house. The picture was taken from the top of the new catalytic cracking unit. The refinery will charge over 25,000 bbls. a day of crude

President of California Natural Gasoline Assn.

C. D. Gard . . .

C. D. Gard, the new head of the California Natural Gasoline Assn., is a technologist with the Union Oil Co. of California. He is chief process engineer in charge of core and natural gasoline laboratories; and engineering design and construction of natural gasoline absorption plants, compressor plants and crude oil dehydration plants.

Mr. Gard has been associated with Union Oil Co. since 1921 in various engineering and natural gasoline manufacturing assignments. He has also served as chairman of the Technical Committee and in other capacities for the West Coast association of natural gasoline manufacturers.

REFINERY MANAGEMENT *and*
PETROLEUM CHEMICAL TECHNOLOGY

July 5, 1944
Volume 36
Number 27

A MONTHLY TECHNICAL SECTION OF NATIONAL PETROLEUM NEWS *incorporating International Petroleum Technology*

War's Swifter Tempo Brings Call to Refiners To Supply Even More Aviation Gasoline

PETROLEUM REFINERS who have already accomplished miracles in meeting war demands for their products are now called upon to make even greater contributions in what, God willing, may be the final phase of the war in Europe.

Military authorities have notified PAW in Washington that a great deal more aviation gasoline than had been anticipated is needed immediately. Of this need PAW Assistant Deputy Administrator Bruce Brown said in a telegram to refiners:

"Cables from commanding generals in active theaters demand increased shipments of aviation gasoline. The all-out air effort has resulted in serious reductions in combat theater stocks. Army Air Forces, Royal Air Force and Navy are presenting most urgent pleas for immediate shipments above and beyond all previous estimates.

"It will be necessary to ship up to 50% more fuel than was previously estimated for consumption in some of the most active theaters during the next two or three months. While Grade A fuel is the product shipped, increased production of components, butylenes, isopentane and isobutane for your own or other refineries is just as vital.

"Push as hard as you possibly can. We have not enough today and will not have enough for several months.

"When and if the aviation fuel needs are met, every special facility will still be needed to produce high quality components for a higher quality fuel already authorized which will give increased offensive power and protect our airmen."

So pressing is the need that provisions have been made to switch volumes of butylenes and other materials from the synthetic rubber program to the manufacture of aviation gasoline. A greater proportion of lead fluid is being diverted from premium motor fuel to aviation gasoline.

However, these steps alone will not be sufficient to meet the greatly increased demand resulting from the upsurge in military activity on many fronts. While new aviation gasoline plants are being completed their production has already been included in the aviation fuel requirements. **What is required to meet the present urgent need is greater output of light hydrocarbons from existing thermal cracking facilities.**

PAW officials state there exists in the present codimer and alkylation units in refineries a surplus production capacity to make the blending agents for aviation fuel of around 25,000 b/d. Increased production of butane-butylene cuts in thermal cracking facilities can supply the feed stocks to take up this surplus capacity.

During an earlier critical period, when larger supplies of aviation gasoline were needed in the African and Italian campaigns, it was proposed to refiners that they operate thermal crackers under more severe temperature conditions to increase yields of C_4 fractions. A method for determining the safe limits of temperatures within which the thermal plants could be operated was presented before the November, 1943, meeting of the American Petroleum Institute, by engineers of the Standard Oil Development Co. (*See NPN Technical Section, Dec.* 1, 1943, *p.* R-555).

Experimental work in increasing temperatures for cracking coil tubes at that time indicated that yields of butylenes could safely be increased 40 to 50%—and these estimates were conservative. Tests by one Ohio refiner indicated even greater increases in yields from a tube and tank unit.

Since this method for determining the safe temperature limits for tubes was announced, these two companies have employed deeper cracking in commercial units. Other refiners have also operated their units at higher temperatures. One small plant making less than 200 barrels of butylenes a day doubled its output by deeper cracking. In no case has serious operating trouble resulted, and in every case substantial increases in yields of C_4 fractions have resulted.

As an additional help to refiners with thermal cracking facilities, the Codimer Sub-Committee of the Aviation Gasoline Advisory Committee of PAW has reviewed cracking operations in all the thermal plants participating in the 100-octane program. Operators have been advised what could be done in their individual plants to increase yields of B-B cuts.

Increased recovery rates of the desired butylene fractions from the C_4 cuts resulting from thermal cracking and other operations are also essential. Technologists of the Technical Advisory Committee of the Petroleum Industry War Council have studied the methods applicable to existing installations. Their reports on fractionating tower operation and other practical reports on increasing recovery rates are available to plant operators.

Pushing the thermal cracking plants under more severe operating conditions as proposed by the PAW means higher per calendar day yields of C_4 cut and results in higher recovery of the valuable butylene fractions. However, it also means that long on-stream time is sacrificed in the war emergency. Thus is emphasized the importance of plant operating and maintenance crews, shorthanded as they are, contributing their part in the refineries' present all-out efforts, to keep their units operating and reduce downtime to the minimum.

An approved means is provided for refiners to recover extra costs incurred in plant operations to increase production of butylenes. Where refiners sell these fractions to other refiners for further processing, with the approval of the PAW, such costs can be included in the price to the second refiner. He in turn recovers his losses under the Aviation Gasoline Reimbursement Plan.

This last call of the military authorities upon the refiners serves to emphasize how different is their position from that of the suppliers of most kinds of war goods. With many of the latter, production will be cut down, perhaps stopped entirely, before the final battles of the war take place. The call of the Army and Navy for many oil products, particularly aviation gasoline, will continue to mount, however, until the final guns are fired.

When and if the production of aviation gasoline of the present fighting grade does catch up with demand, it is planned to manufacture an even superior grade, which will serve as a better fighting tool for our flyers. All possible yields of the desired light hydrocarbons will continue to be needed for this improved fuel. Authorities say it will be impossible to over-produce butylene while the war lasts.

The present circumstances show that, while our armies and battle fleets are in action, there can be no letup in the manufacture of aviation gasoline. **For every barrel the oil industry fails to supply, lives will be needlessly lost and blood needlessly spilled on the fields of battle.—V.B.G.**

Natural Gasoline Makers Contribute to War Demand For Petroleum Products

ALMOST WITHOUT EXCEPTION every manufacturer of natural gasoline or liquefied petroleum gases is contributing in some manner to the war effort. In many cases production from individual plants is so small it has been economically impractical to increase plant facilities. Where this situation exists, the products have been channeled to a refiner who combines the output of a number of such plants and thus has sufficient material to justify separation of hydrocarbons vital to the production of aviation gasoline or synthetic rubber and civilian products.

Of the new plants built, some are conventional natural gasoline plants, others have super-fractionating facilities and the balance are cycling plants. Still another way in which natural gasoline manufacturers aid the war effort is by engaging in pressure maintenance projects, whether or not the field is of the "distillate" type.

Altogether, according to Director J. E. Pew of the Natural Gas-Natural Gasoline Division of the Petroleum Administration for War, the natural gasoline industry has spent $65,000,000 since 1939 to increase production by an estimated 129% by the end of 1944. By that time he expects production of light hydrocarbons by natural gasoline manufacturers to reach 320,000 b/d. By contrast, 1939 production was about 140,000 b/d.

Calling the industry's effort a "magnificent response" to war demands, Director Pew told the recent convention of the Natural Gasoline Assn. of America: "Today better than 15,000 bbl. of commercially pure isobutane are being separated in natural gasoline and cycling plants and being utilized in aviation alkylate, in addition to thousands of barrels being produced as mixtures with normal butane and in natural gasoline, which is being separated at refineries and used in aviation alkylate.

"During the past winter (1943) about 57,000 b/d of butanes and propane were marketed as liquefied petroleum gas for fuel. The remainder of these products are being used for aviation base stock, isopentane in 100-octane aviation gasoline, blending in motor gasoline, butadiene for synthetic rubber, styrene, explosives and other essential chemicals. The refiner has found many new uses for light hydrocarbons in meeting the demands for war products."

Deisopentanized Natural Gasoline

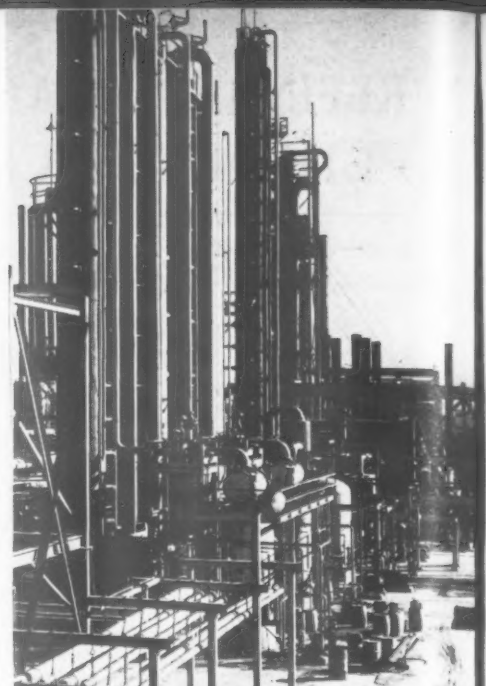
From a relatively small number of plants, those of over 15,000 gal per day capacity having "pentane splinters", is coming a natural gasoline of a different type from that formerly produced. It is known as "deisopentanized natural gasoline," and stems from the requirements of government "requests."

PAW Directive 75, effective Nov. 1, 1943, and several times amended since, requires that all natural gasoline plants of 10,000 gal per day capacity or refineries producing a C_4 cut amounting to 5% by volume of liquids produced, or if C_4 cut contains 20% or more by volume of butylenes, isobutane, or both, must channel such product to aviation gasoline or synthetic rubber manufacture. Along with this, urgent and repeated requests have been made for the segregation of isopentane as well.

Deisopentanized natural gasoline averages a 7-lb Reid vapor pressure product, with initial boiling point approximately that of normal pentane, 97°F., and with an end-point near that for normal decane, 345°F. Since the vapor pressure of pre-war motor fuel was around 10 R.V.P., according to Barnard and Forrester[2], the post-war market demand for this residual material is not expected to be great.

Some refiners buying the deisopentanized material are using it as a raw-materials source rather than a blending agent for motor fuel manufacture. It may be reformed to increase octane number or special cuts are taken for aromatization or other processing. It also can be dumped into crude pipelines, where it will reduce the viscosity of the crude being pumped and thereby increase the capacity of the line.

Another way of disposing of this material, which remains after the extraction of propane, iso- and normal butane and isopentane from a natural gasoline, is by "blending back" with normal butane. This provides a means for utilizing in motor fuel some of the butane not needed for the war effort in 100-octane gasoline or chemical manufacture, and for which there may not be a ready market as domestic or industrial fuel because of economic or other reasons. Even if this is done, the resultant material is not a "natural gasoline" as the term is applied in the trade, although the vapor pressure attained may reach any of the seven standard vapor pressures recognized by the trade. Butane cannot wholly take the place of the isopentane which has been removed and allow distillation specifications to be met.



Fractionating towers at Phillips Petroleum Co. gasoline plant, Borger, Texas

Theoretically, the deisopentanized stock might be made to approach a conventional natural gasoline in octane rating, vapor pressure, distillation and other requirements by blending back with a judicious amount of light distillate from cycling plants, in addition to normal butane to adjust vapor pressure and help meet front-end distillation requirements.

Some Stumbling Blocks

Practically, however, there are several stumbling blocks which generally prevent this practice on economic grounds:

(1) A source of distillate must be available which has the necessary characteristics to permit such blending and for which there is no other more economically profitable use.

(2) Strict technical control must be maintained to see that the final blend meets trade specifications for vapor pressure and distillation.

(3) Lead susceptibility must be such as to at least not depress and preferably improve the ratings of the blended motor fuel made with it.

This "deisopentanized natural gasoline" is strictly a "war baby", many producers feel. It is not considered as good a blending agent as a conventional natural gasoline from the standpoints of front-end volatility, octane rating and lead susceptibility. Possibly it may affect the heavy end of the blended motor fuel distillation curve as well. The refiners are using it and natural gasoline manufacturers supplying it solely as a war measure; it is part of the price the Nation is paying for more and more aviation gasoline. The product is not available in great quantity compared

with the overall volume of natural gasoline, because of the comparatively few producers making it.

Here are some typical examples of what has been done at some natural gasoline plants to help the war along:

Central-Plant Stabilization

One natural gasoline manufacturer, the Lone Star Producing Co., had four plants scattered around a fairly large area. To meet the call for isobutane, isopentane, and other liquefied petroleum gases meant the installation of additional (and expensive) fractionating equipment at each of the plants. The individual production at these plants was not considered sufficient to make the venture a paying one. Company engineers decided, however, that if at least 75,000 b/d of production could be made available at a central point, requiring the installation of only one set of additional fractionating equipment, the economics were favorable since the fields in which the four plants were located were now "settled production."

But there were other stumbling blocks: Priorities for all-new equipment then were difficult to obtain and, once in hand, would not assure prompt delivery. Moreover, there was cost to be considered. Also, the plants had some fractionating equipment which would be rendered idle if central processing were introduced.

A general survey of all company properties for idle or prospective idle equipment was instituted. The result was that when the plant design was completed for the central installation, only three large fractionator towers, some fittings, valves and piping, a few control instruments and other miscellaneous items had to be newly acquired. Charge, reflux and other pumps, tankage, boilers and other necessities were to come from company properties or were purchased, second-hand, from salvage yards or other operators.

One of the plants, at Ranger, Texas, already had facilities for producing propane, butane and stabilized natural gasoline. This was chosen as the central plant at which facilities were to be added. Another plant had a depropanizer and eventually was robbed of it for the central plant. The rest had only conventional stabilizing equipment for making Grade 26-70 or else made either a 34-lb natural or simply de-ethanized their product in a simple fractionator (stabilizer) which also removed some of the propane. (In such operation, the gasoline is stripped from the absorber oil and run to the stabilizer or fractionator, where ethane and some of the propane is rejected overhead and the balance shipped to the central plant. The reject—dry gas—is used and sold for fuel gas.)

Fractionation equipment at this plant comprises a 30-tray de-ethanizer, 50 ft. by 48 in.; 30-tray depropanizer, 50 ft. by 48 in.; 30-tray debutanizer, 70 ft. by 54 in. (new); 66-tray deisobutanizer, 112 ft. by 36 in. (new); while the deisopentanizer, 112 ft. by 84 in. (rebuilt from salvage by outside shop), has excess tray capacity for the job at hand which generally requires not less than 70 trays. Steam requirements are met by a battery of four 100-hp locomotive-type boilers with nine more available for stand-by with a minimum of reconditioning.

Bulk of the charge reaches the plant through 50-odd miles of pipeline, newly-laid for the purpose and fabricated from reconditioned stock. Approximately 25% is hauled from outlying plants by "butane" trucks because the small individual quantities collected make pipeline transportation impractical.

The average composition of the charge to the central plant approximately 140,000 gal per day is as follows:

Propane and lighter	**22.65%**
Isobutane	**6.95**
Normal butane	**26.64**
Isopentane	**7.98**
Normal pentane	**10.03**
Hexanes and heavier	**25.75**
Total	**100.00%**

From this charge stock propane, isobutane, butane, isopentane and deisopentanized bottoms are produced. Isobutane and isopentane are supplied to aviation-gasoline and synthetic rubber manufacturers. Butane is supplied for industrial use and as a fuel; propane as a fuel. Excess butane, if any, can be blended with the deisopentanized bottoms for use in civilian motor fuel or for other disposal.

Distillate plants are contributing to the war effort in several ways besides the obvious recovery of light ends, conservation of natural resources and "distillate" production. One plant is making 87-octane aviation gasoline by careful fractionation of the distillate to standard specifications and subsequent addition of tetraethyl lead.

All distillate plants cannot operate as does this particular plant, however, and through no lack of desire on management's part. Much depends on the characteristics of the distillate itself, which varies from field to field and from district to district, just as the composition of natural gasoline itself varies. Several manufacturers are selling their distillate—some after removal of light ends and others "as is", as a charge stock for catalytic cracking. One plant in particular has a long-term contract with an East Coast refiner by which distillate is dumped into a crude line. Here it acts much like natural gasoline in reducing viscosity and increasing effective line capacity.

Other War-Effort Contributions

Still other distillate manufacturers, separating light ends from distillate, also produce a good grade of kerosine and either use the heavy residue as an absorber oil or sell it for fuel oil or catalytic cracking stock. Again, much depends on characteristics of the distillate.

One cycling plant operator has a unique arrangement in that he is operating a government-owned 100-octane aviation gasoline refinery not far away from his cycling plant. Cracking stock for the refinery is supplied in part by the distillate from the cycling plant, and the balance from crude petroleum also produced in the area. Raw material for alkylate and blending components comes

Operating pressures range from 40 pounds to 600 pounds in these reabsorbers at the cycling plant of Humble Oil & Refining Co., at Katy, Texas

in part from the cycling operation and from catalyticaly cracked gases from refining. The two plants—cycling and 100-octane—are physically separated but are co-ordinated in operation for the war effort. Gas from the cycling plant is returned to the reservoir.

These specific examples above are but a few from a list of many that show the ingenuity of natural gasoline manufacturers and cycling plant operators in finding ways to contribute to the oil industry's wartime program.

In general, engineers say, the bulk of the $65,000,000 the natural gasoline industry has spent since 1939 in increasing its production has been used to build cycling plants. This is new construction with a large proportion of new materials. Most of the balance is accounted for by construction of new natural gasoline plants using a lesser proportion of new materials. A relatively small amount went for plants built or converted by means of equipment salvaged from abandoned plants and refabricated on the spot. Some of the boost in plant production has come about because industrial requirements have necessitated larger flows from present gas fields serving the plants. The larger the gas throughput the more liquid products extracted, regardless of any alterations or additions to the plant's extractive and fractionating equipment.

In general, relatively few plants east of the Rockies have installed deisopentanizing equipment. Plants with such equipment (excluding cycling plants) generally exceed 15,000 gal per day total liquid products. Considering that the average natural gasoline contains approximately 20% by volume of isopentane, a 15,000-gal plant could produce about 3000 gal per day, or nine tank cars monthly of isopentane. The basis of this calculation is an average composition, 40-lb Reid, vapor pressure, natural gasoline showing the following composition, assuming the plant was operating on total butane extraction:

Component	Typical Inspection Data % by Volume	Average Range of Composition % by Volume
Propane	1.07 - 1.70	0 - 1
Isobutane	14.75 - 15.31	10 - 18
n-Butane	41.79 - 41.96	38 - 40
Isopentane	12.41 - 13.83	10 - 20
n-Pentane	10.44 - 11.61	10 - 20
Hexanes & Heavier	16.76 - 18.36	10 - 20
Reid vapor pressure @ 100°F.		
Calculated 41.5 — 43.9 psi		
Determined 36.8 — 40.4 psi		

Similarly, it may be generalized that few plants producing less than 10,000 gal per day have been able to install butane splitters because of unfavorable economics. Using the table above, a 10,000 gal plant would produce not over 18% of this volume as isobutane, amounting to 1800 gal per day and less than a tank car per month.

There are no reported instances of either natural gasoline or cycling plants installing units for isomerizing butane or pentane. Instead, several refiners have installed or now are installing such equipment, securing the needed C_4's or C_5's from refinery gases and natural gasoline manufacturers.

According to one natural gasoline plant designer, some manufacturers are planning for the future while building new plants. Believing there will be less market for natural gasolines in blending postwar refined motor fuels because of new catalytic cracking facilities some of their plants are being equipped with lead-blending facilities. Natural gasoline produced will be stabilized for proper volatility and blended for proper distillation characteristics, then leaded to at least the equivalent of housebrand if not premium gasoline.

Discussing present plants, this engineer-authority said that all components of the industry had installed "whatever the government would permit" in the way of additional facilities, and, depending on the size of plant, they had used a large amount of secondhand material in the process. Restrictions, he said, prevented the use of more than 20% of new material in old plants. Thus old, abandoned plants were torn down and facilities refabricated and re-erected elsewhere to increase extraction efficiencies on butane from its prewar figure—50 to 60%—to the 80's or even the 90's. This permits them to recover up to 95% of the butane originally in the gas, which high rate of extraction would bring about up to 65% recovery of isobutane.

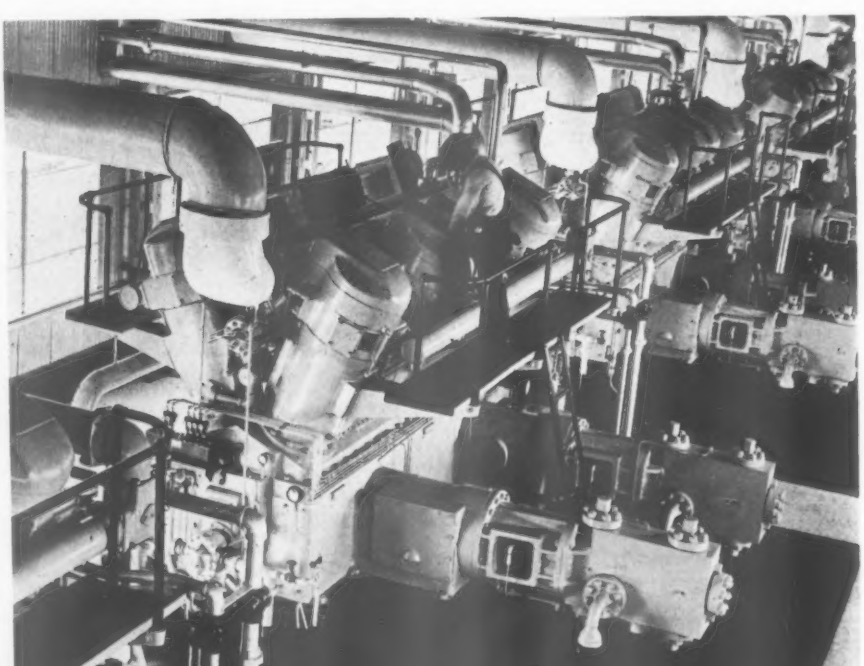
The same authority said that cycling plants, accounting for large proportion of the industry's overall 129% increase in production since 1939, were forced to use up to 20% of used material in their construction. Relatively few of the "new" cycling plants were built of entirely new materials.

It is difficult to generalize on what was done to the gasoline plants by classes based on their size, to provide for their contributing materials for war products. Conditions affecting the individual plant were the most important factor. Generally, however, this work can be divided into five categories: 1—Increased circulation of absorbing oil: The increase in circulation rate necessitated the addition of more pumps for increased volume pumped per hour, or the substitution of a larger pump. Corresponding changes in the operation of the fractionating equipment were required and sometimes additional capacity in fractionator towers.

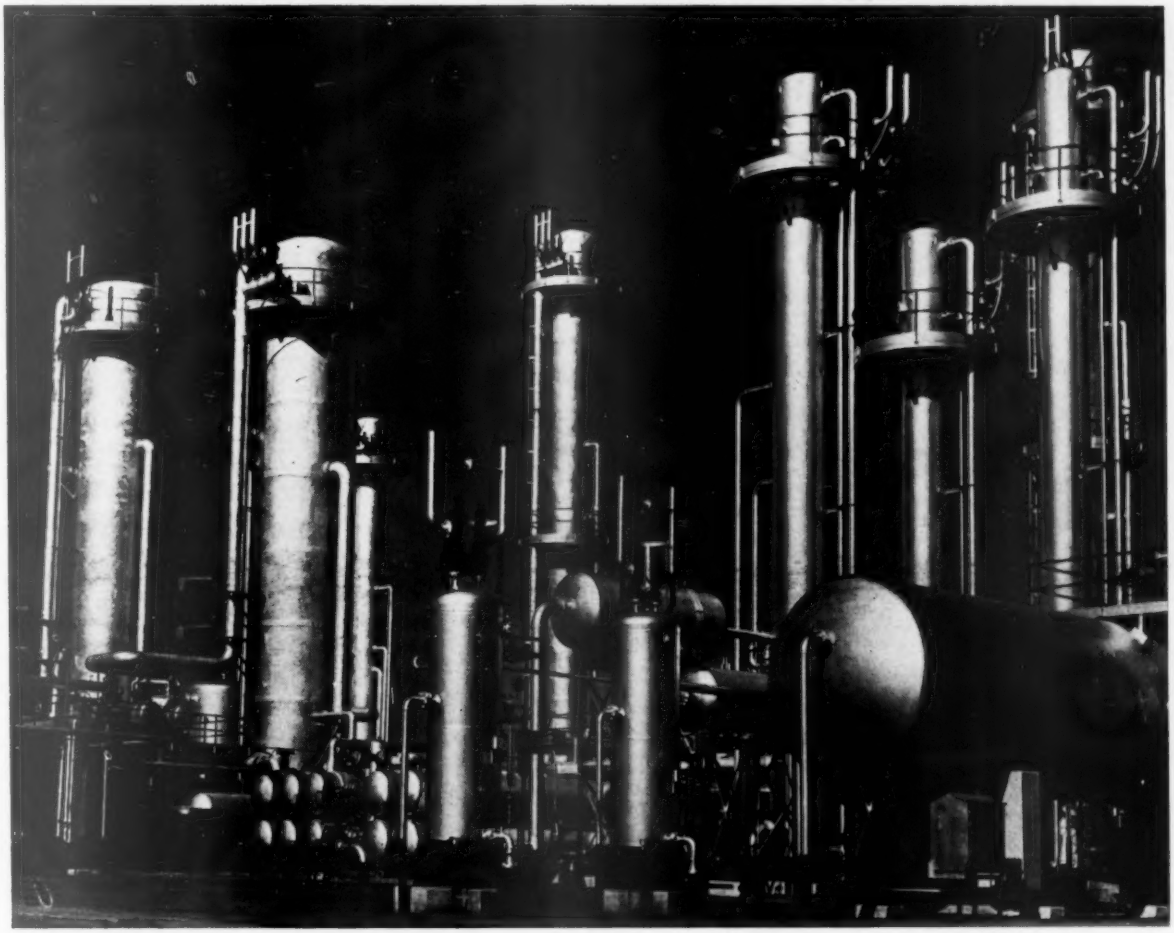
2—Increased absorption pressure. Unless located in a high-pressure gas field, this change required installation of additional compressor capacity *if* old equipment was to be used which was not rated for the higher pressure. Sometimes two or more compressors were added, one, say, for the final compression to desired degree and the other for additional initial capacity. Generally an additional fractionator tower also was required to handle the increased gas volume from the absorbers, and perhaps an absorber rated for the increased operating pressure.

3—Additional fractionating equipment. Some plants having only three towers increased their fractionating facilities to four or even five towers, including facilities for separation of isobutane (or isopentane).

4—Increased stripping pressure. Some plants increased the pressure on their



Interior of compressor building in Humble's Katy cycling plant, where the pressure of gas is increased from 1800 pounds suction to 3150 pounds discharge



Distillation area of the cycling plant of Humble Oil & Refining Co. at Katy, Texas, showing reabsorbers, stills and stabilizer

strippers, which did not require additional compressor capacity and added another tower or installed a larger stabilizer to handle the increased load.

Changes in some plants do not fall entirely into any of the above four categories. In these plants a combination of two or even all of these changes were made to meet war demand.

5—Increased plant throughput. Plants in this category increased their production not by adding equipment, but because of the increased throughput caused solely by increased industrial demand for natural gas in the fields supplying them. Even if their extraction efficiencies dropped by reason of increased throughput, actual net production was increased for there was more material "going by."

These latter plants are in many cases channeling their output into crude pipelines, where the light material functions to reduce the viscosity of the crude and thereby increases the capacity of the line; at the same time the producer's transportation problem is solved. However, many plants are not so fortunately located with reference to pipelines and thus have been forced to sell their 40-lb (or higher) product to refiners for separation of the desired components.

Widely divergent opinions have been given by many authorities on postwar demand for light hydrocarbons which are the natural gasoline industry's stock in trade. In references previously cited, for example, Pew[1] takes the position that the supply of light ends will greatly exceed refinery demand as a result of large catalytic cracking facilities brought about by the war. He advocated "pooling" in central plants ventures where finished motor fuels could be produced and research carried on to find other, new outlets for natural gasoline products. Barnard and Forrester[2] doubt any large excess, and postulate instead an approximate balance except for local areas where surpluses may develop.

A widely-known designer of natural gasoline plants had this to say of the future: "The trend toward greater separation of light ends is here to stay. Because of the great increase in refinery construction, refineries have about reached the end of their programs for installation of new facilities for the next 10 to 15 years. Many of them are overdesigned, deliberately so to play safe with their then-untried new processes, and this will tend to keep them fairly static for a long time.

"The new catalytic capacity will supply enough light ends to secure the desired vapor pressure of motor fuels without the use of natural gasoline. Many of the recently-constructed natural gasoline plants have recognized this condition and are built with the provision in mind of ultimately installing leading facilities, if they do not have them now."

"Straight-run" natural gasoline from these plants is the equivalent if not better than "straight-run" gasoline produced from crude, in this authority's opinion. Sufficient light ends can be removed from them, he states, to put the distillation curve where it should be and still have proper volatility, and leading will permit octane competition with other gasolines. Cycling plants whose products competed with refined gasoline prior to the war in some marketing areas will resume this competition when the opportunity is provided, it is believed. Costs of motor fuel produced at natural gasoline and cycling plants are such that they can compete successfully with motor fuel refined from crude because elaborate refining equipment is not necessary, authorities state.

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[1] Pew, J. E., "An Address to the Natural Gasoline Association of America". N.G.A. 23rd Annual Convention, Dallas, April 14-

[2] Barnard, D. P. and Forrester, J. H., "Will The New Processes Affect The Post-War Light Ends Situation?" N.P.N. 36, R-342 (1944).

5 New Units Boost Aviation Gasoline Output of Gulf Coast Refinery

NEW 100-octane gasoline manufacturing facilities consisting of five principal operating units have been installed in the refinery of Republic Oil Refining Co. at Texas City, Texas, at a cost of more than $10,000,000 as a result of a contract between the Defense Plant Corp. and the oil company.

The aviation gasoline plant was formally dedicated June 14, with hundreds of Army and Navy officials and government, industrial and labor representatives gathered for the occasion. Deputy PAW Davies made the principal address.

The new facilities provide for the Republic's Texas City refinery charging nearly 25,000 barrels a day of crude, to process into aviation gasoline and other essential wartime petroleum products. It has capacity to produce more than 4000 barrels a day of 100-octane gasoline. The new units include:

Gas Oil Flash Unit: A vacuum fractionating system to which is charged topped and reduced crude from the crude fractionating units, to prepare a gas oil fraction for charging stock for the catalytic cracker.

Thermal Reforming Unit: Charging stock is straight-run naphtha from crude fractionation. It produces a butane-butylene fraction for the alkylation unit and a quality, high-octane motor fuel which can be used in the 80-octane "all-purpose" gasoline of the Army.

Fluid Catalytic Cracking Unit: This produces butane-butylene fraction for the feed for the alkylation plant and aviation gasoline base stock to be blended with finished alkylate for 100-octane gasoline.

Gas Concentration Unit: Segregates the butane-butylene fraction from the gases resulting from thermal reforming and catalytic cracking operations.

HF Alkylation Plant: From a butane-butylene charging stock, it makes alkylate from the chemical reaction of isobutane with butylene.

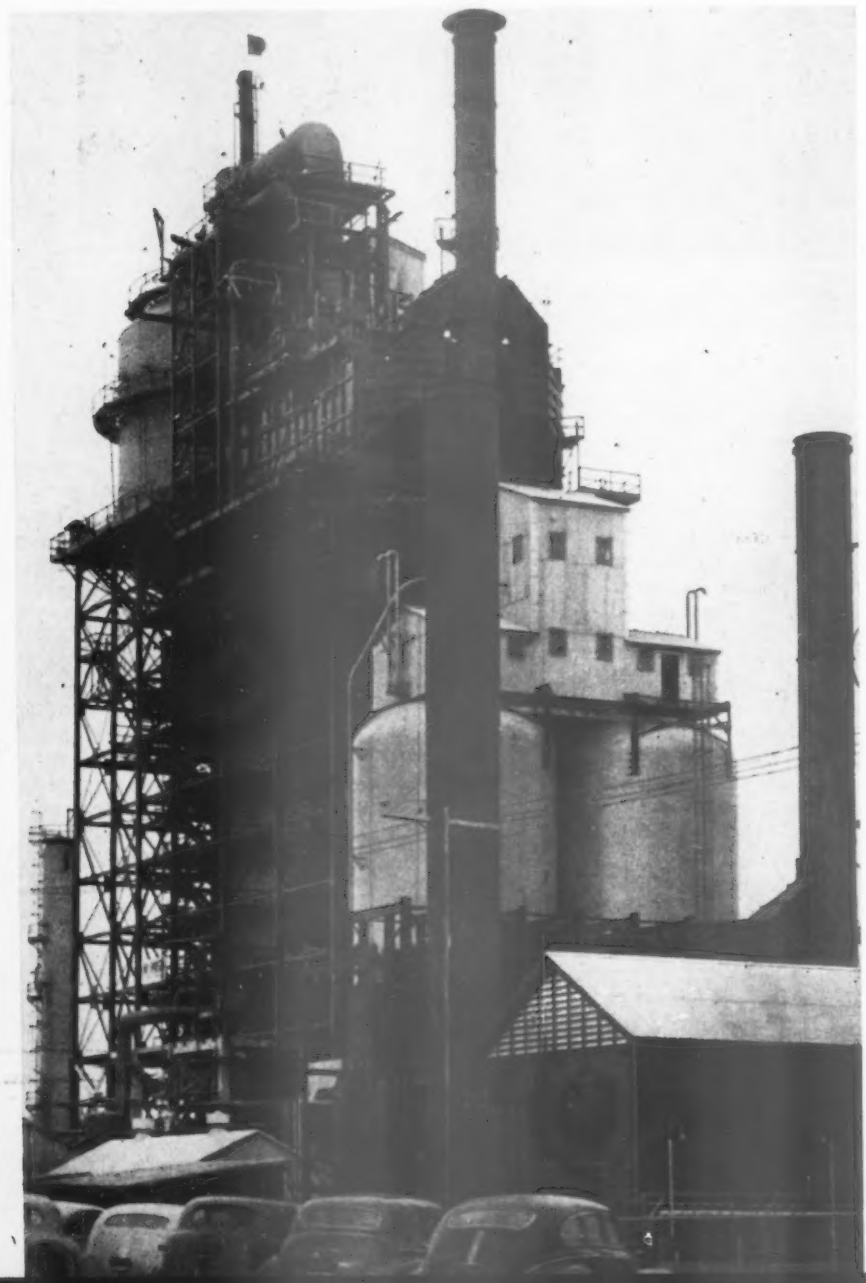
New tankage, fractionator towers, new water wells and cooling towers, more boiler capacity and additional laboratory and office space have also been constructed. Most of the new equipment was designated by Universal Oil Products Co., especially the catalytic cracking, alkylation and reformer units.

The "old" plant which now has been changed in operation to produce materials for the ultimate output of 100-octane aviation gasoline, consisted of three topping units (tubular type) and two thermal crackers (designed under Gasoline Products Co. license). A fourth topping unit, designed by Frick-Reid Supply Corp., Refinery Division, the contractors for the present construction program was added in 1940. Capacity of the thermal cracking equipment is 10,000 barrels a day.

Operation of Plant No. 1

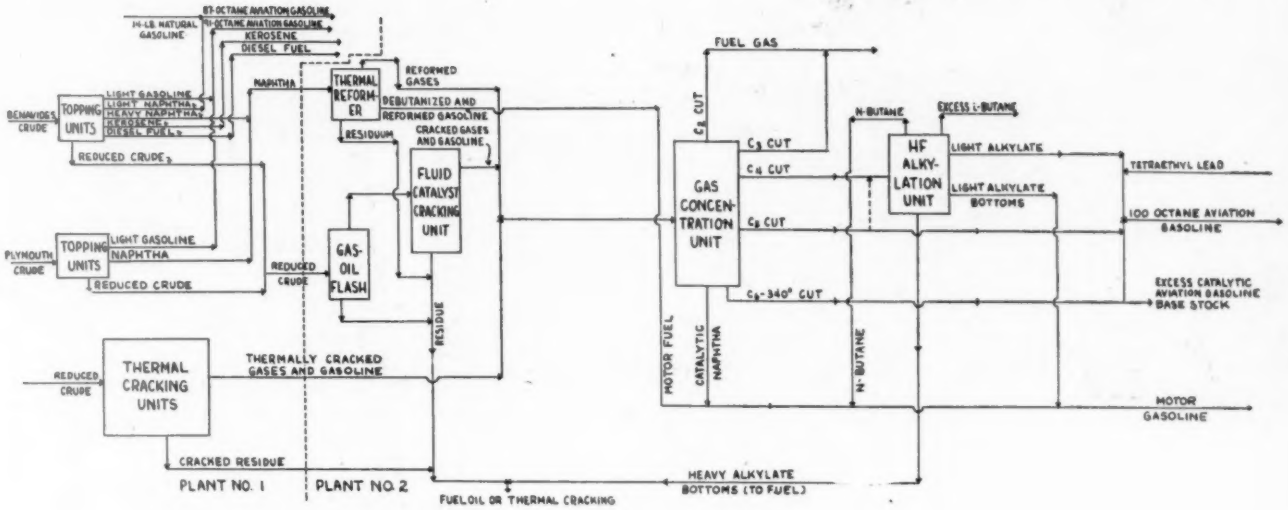
Selected Gulf Coastal crudes, high in qualities necessary for 100 octane gasoline manufacture constitute the charge stocks for the plant. When the refinery as a whole goes into ultimate operation it is expected to charge a total of 24,675 b/cd to four topping units.

One problem which has lately been causing difficulties in the topping operation is expected to be eliminated in the very near future. Considerable corrosion and plugging from salty crude has been experienced. Chemical desalting, for which facilities now are on order



Fluid catalyst cracking unit dominates the plant with its 10,000 b/d charge capacity. Furnace visible in right foreground is not a part of the "cat", serving instead as a naphtha reformer. "Cat" charge stock is heated by exchange with hot catalyst

Flow Diagram of Republic Oil Refining Co.'s Texas City Plant



and under construction, will remove this difficulty, saving labor costs, production time, and equipment and parts expense caused by frequent shut-downs.

The two thermal crackers will have a combined charge of 9000 b/d of reduced crude. However, this charge is not strictly a reduced crude in the normal sense. Instead, a mixture of thermal reformer bottoms, catalytically cracked, and reduced crude bottoms will constitute feed. Residue will be sold as fuel. Moreover, as demand dictates, the feed normally going to the cracker can be segregated as fuel oils instead of being further cracked. This adds to the plant's flexibility but would require a make-up of the B-B fraction thus lost.

Straight-run products from the topping units represent the initial contribution of the "old" or No. 1 plant to the war effort. The light gasolines and naphthas are blended to make both 87 and 91-octane aviation gasoline, with kerosine, Diesel fuel and reduced crude constituting the remainder.

Plant No. 2 Operation

Plant No. 2's main business is making 100-octane aviation gasoline, although as byproducts it manufactures a 76+ clear octane number (C.F.R. Motor Method) motor gasoline and fuel oil.

Reduced crude from topping operations is charged to a 17-plate gas oil flash drum which, under vacuum, removes virgin gas oil overhead and crude bottoms, for fuel or thermal cracking, recovered as bottoms. Reflux for this operation is obtained by taking off a side stream, cooling it by exchange with incoming crude, and returning the cut as reflux. This preheat is not sufficient for direct charge to topping but does permit use of a smaller heater on one unit.

The catalytic cracker charge which is virgin gas oil, is heated to cracking temperature solely by injection of hot catalyst. There is no heater for this unit. Catalyst returning from regeneration at 1000-1100°F. finishes the job begun by heat exchange with hot oil from the fractionator which cuts catalytically cracked effluent into two streams. As the sequences of conventional fluid catalytic cracking operations are well known, they will not be further described here.

Effluent from catalytic cracking is separated into heavy bottoms and overhead in preliminary fractionation. Overhead, consisting of gases and gasoline, goes to the gas concentration unit for separation.

Naphtha from topping operations constitutes the charge to the naphtha reformer, which has a capacity of 5000 b/d. Here again the operation is entirely conventional in the standard unit. Reformed gases from this unit are recovered by debutanizing the reformer gasoline, the debutanized product going directly to motor fuel blending. Gases go to the gas concentration plant, while heavy residuum is used as fuel oil.

The gas concentration plant serves as a central unit for segregating gases. Reformed and thermally cracked gases (C_4 and lighter) plus compressed gases and liquids boiling below 400° F. from catalytic cracking constitute charge to this unit. Gases are compressed to approximately 220 psig for charging the absorber. Since catalytic operations are carried out at essentially atmospheric pressure, 3000 hp of compressor capacity had to be installed to handle an estimated 15 to 20 million cu. ft. of catalytically cracked gases. Compressors discharge at 225 psig.

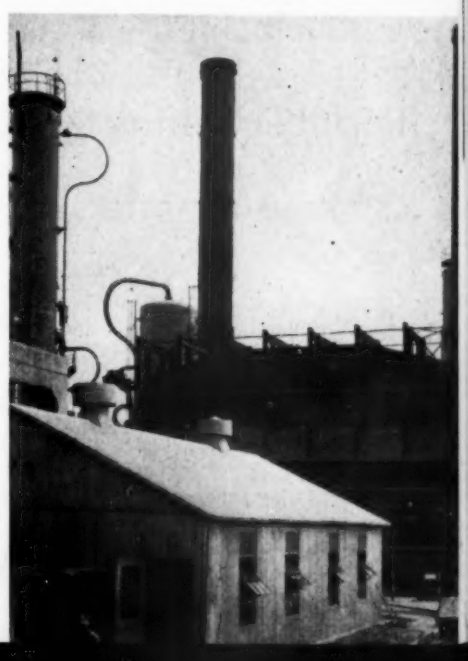
Catalytically cracked gasoline is split into 340° F. end point material and a naphtha cut boiling from 340 to 400° F. The naphtha cut is used for motor fuel blending, the 340° E.P. cut as aviation base stock.

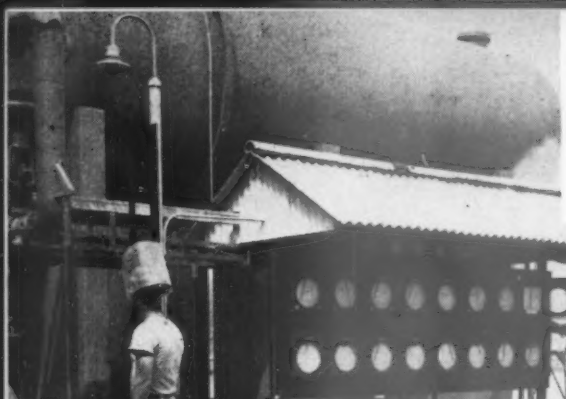
After removal of C_5 and C_6 fractions, the balance of the gases is fractionated into C_1-C_2, C_3 and C_4 cuts. The C_1-C_2 cut is charged to the refinery fuel gas system, and propanes generally also. The processes involved here are simple, though closely controlled fractionation.

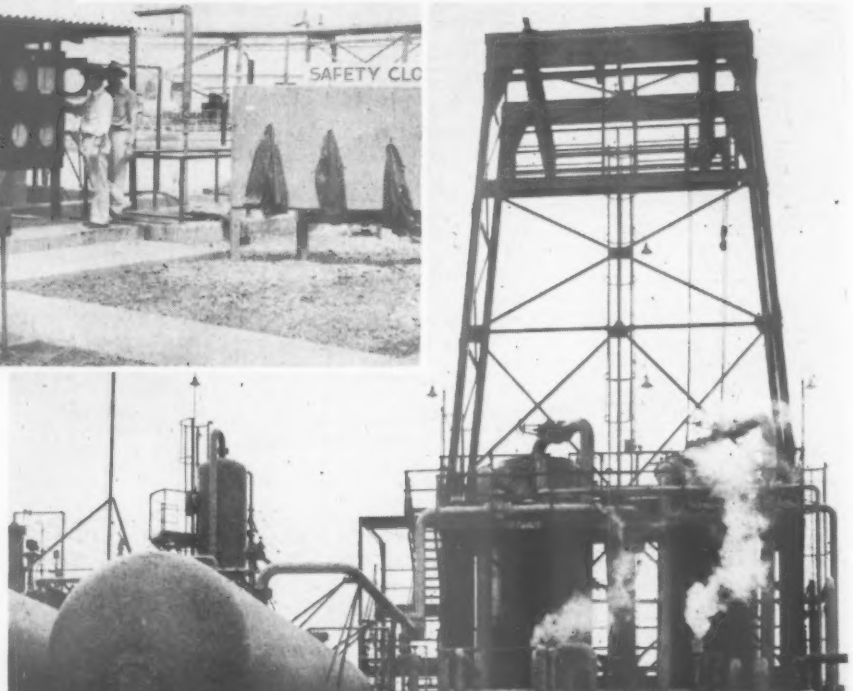
The C_4 cut, which may contain a small amount of pentanes, is charged to anhydrous hydrofluoric alkylation, the unit being the standard design of Universal Oil Products Co. using an impeller-type contactor, which has been described in the literature. An interesting feature of this unit is the removal of accumulated water from the acid by fractionation in a silver-lined tower. Also, connections are made so that some C_3 and C_5 olefins, or both, in addition to the conventional C_4 cut can be alkylated.

Of the alkylate produced, a small amount of bottoms will be available for motor fuel blending. Some butane will also be available for blending or other disposal. The products available for blending of 100-octane aviation gaso-

Building in foreground is control house for fluid cat cracker. Furnace visible in background is for naphtha reforming







Left, control board for the AHF alkylation plant was built "outside" because of the prevailing mildness of Texas' weather. Visible at left is one of the process storage tanks while at right is shown a rack on which safety clothing is kept readily available. Below, alkylation contactors, where alkylate is made from C_4 paraffin and olefin hydrocarbons, are of the standard U.O.P. type

line are aviation alkylate, catalytic base stock, and C_5 cut. One hundred-octane production capacity in excess of 4000 b/d is anticipated, officials say—more bad news for the Axis.

Plant Auxiliaries

The new installations imposed an additional load on existing facilities, which made necessary the construction of more steam capacity, greater water supply, and additional office and laboratory space. Four new boilers, of 935 hp each, were installed to generate steam at 300 psi with 75° of superheat. If converted into electricity, they could supply the needs of 35,000 homes. Two new water wells, 800 ft. and 1100 ft., were drilled for drinking and process water, respectively, to augment two similar wells previously serving the plant.

It is not necessary to treat the drinking water, but for boilers the water is zeolite softened and acidulated with sulfuric acid. Cooling water, while not softened, is treated with quachrome glucosate for corrosion control and with tetraphospho-glucosate to inhibit scale formation.

All in all, the new construction required about 23,000 tons of steel, exclusive of the 100 miles of various sizes of pipe—1 in. to 24 in. diameter—required for the various utilities. To conserve steam and reduce fuel cost also, turbines used for direct power, on pumps, blowers, etc., exhaust steam at 40 psig, saturated. The 40-lb. steam is used in condensing turbines powering circulating water pumps and cooling tower fans; this steam also is used for reboiler heat in gas plant fractionator columns.

Republic Refinery Cited as Product Of Free American Enterprise

"The plant we dedicate today to the service of the Nation at war—the plant of the Republic Oil Refining Co.—is a typical unit in the American industrial system", stated Deputy PAW Davies, in his address at the dedication of the plant.

"It has built into it all the creative quality, the skill, the vigor and the drive, all the unfettered thought and action that makes the American economy solid and makes it safe. Here there is at work no blighting monopoly, no coercive government force, no interference with free and independent action. So characteristically American, this unit is well named the plant of the 'Republic'.

"It has been built by men and women who are their own masters, in expression of their own genius and with the assistance and support of a government which they themselves have created and which they control."

Typical also of the opportunities for individual initiative and advancement that have been created by active enterprises in the oil industry is the Republic Oil Refining Co., which owns the Texas City refinery.

"The management of your company have all held the same kind of jobs that you folks have held," said O. D. Robinson, its president, in his address to the plant workers at the ceremonies.

He recited the humble start in business careers made by some of the present officials:

Harland I. Casteel, a director, started out as a coal miner, said Mr. Robinson.

John M. Gardiner, vice president in charge of sales and Washington operations, started as a sales department clerk.

E. L. Sauer, assistant secretary of the company, for his first job read meters for a public utility company.

J. E. Kelly, vice president in charge

(*Continued on p. R-424*)

Salvaged Fittings and Shop-Made Parts Lick Maintenance Material Shortages

GETTING around material shortages has been one job which the maintenance department at the No. 1 Refinery in Cleveland of the Standard Oil Co. (Ohio) has solved with ingenious improvising. Blessed with a maintenance crew which takes pride in figuring out ways to overcome such obstacles and shortages, this refinery has eliminated most of its material bottlenecks by reclaiming and putting back into active service fittings which would normally be thrown away, and by making many replacement parts in its own shops.

They've worked out ways for relining even the smaller sizes of elbows and for refacing corroded pipe flanges. They have developed a new method of renewing seats in header boxes, which saves time and does a better job. They preform special sections for lining over rivet heads in stills, make their own bubble cap trays and drill their own tube sheets.

One item which has been particularly troublesome has been cast steel flanged elbows. Inventories have been used up, suppliers can't furnish immediate delivery. But the elbows continue to corrode and wear out. Standard has been keeping its old ells in service and making them last longer simply by relining them with 16-gauge stainless steel, 18-8 composition.

Relining the larger sized elbows (10 and 12 in.) is nothing new. Standard has been doing it for five or six years with excellent results. But when shortages began to develop, they started experimenting with methods of forming liners for use in smaller sizes—3, 4 and 6 in. elbows.

Forming the liner to fit the inside contour of the large elbows is relatively simple, despite the fact that a double curvature is involved (the circular cross section shape of the ell plus the radius of the bend). The curvature isn't as sharp in the larger sizes, requiring less deforming of the flat metal stock used for the lining. In addition, there is sufficient room inside a 10 or 12-in. ell to form the metal with a ball peen hammer right to the inner surface to be lined.

Lining the smaller sizes, however, presents a more complex problem. The curvature, because of the smaller diameter, is much sharper and more pronounced. And there is insufficient space to form the liner inside the ell, requiring some sort of mold or die for preforming.

The solution to the mold problem was an old elbow cut in half longitudinally. It makes a perfect female die for forming the flat metal to the proper contour, using an ordinary ball peen machinist's hammer to knock the metal into shape (see Fig. 1).

Developing the blank shapes for the various pieces that make up the lining, however, was more difficult. First they had to be of such shape as to require a minimum of metal distortion and thinning during the forming process. Then they had to be divided in some manner which would make it easy to insert the formed pieces into the elbow being lined. Elbows, unfortunately, aren't in the shape of a true radius; they straighten out at each end.

Standard's maintenance men solved this problem by forming the true radius portion of the liner in six strips, with two additional pieces to take care of the straight portions at either end. The flat shapes of these developed blanks for the 4 in. elbow are shown in Fig. 2. The same relative shape, of course, would hold for any size elbow of the type illustrated here.

To lay out the blanks, Standard uses a set of primitive but entirely satisfactory templates, cut from ordinary roofing paper. If many elbows of any one size are lined regularly, of course, a set of sheet metal templates would hold up longer and be more serviceable. The blanks can easily be cut from the 16-gauge stainless steel sheet stock with a band saw, or, as Standard does, with a small portable electric shear as shown in Fig. 3.

Once formed, the six sections for the true radius portion of the ell are tack welded together. The longest joint or seam, however, the one along the largest radius or "back" of the ell, is left unwelded (Fig. 4). This is done so that the section can be sprung slightly,

Fig. 1—Forming the liner for a 4 in. elbow. An old elbow split in half serves as a mold, the liner being formed in sections as shown below

Fig. 2—Approximate shapes of developed blanks for liner to be inserted in 4 in. elbow. Two of each piece shown are required to completely line the ell

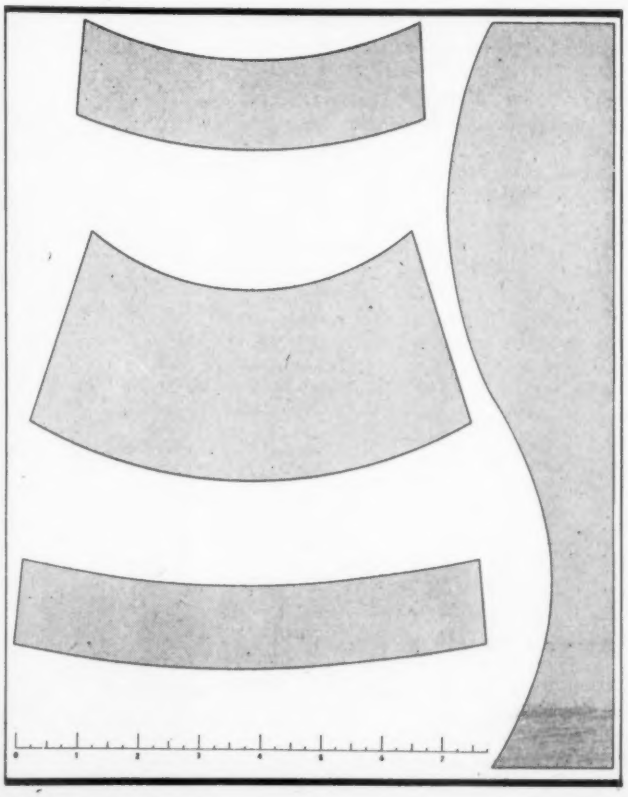


Fig. 3—Cutting blank for section of elbow lining with an electric shear

if necessary, when inserting it into the elbow.

The only work that needs to be done on the elbow itself prior to installing the liner is to clean it out, using an acetylene torch, although it is thought sandblasting to get a bright clean metal surface might possibly be better and would give a better weld.

With the preliminary work of forming the liner and cleaning the elbow taken care of, all that remains is to insert the various sections of the liner in the ell and weld them in place.

On the larger elbows, the sections of the liner may be of considerably greater area than on the small 4 in. size. To get a good tight fit between these large sections and the ell, it is customary to drill or punch small holes (about 7/16 in.) through the liner approximately every 4 inches and to weld through these points directly to the old ell.

Only one difficulty has ever been encountered by Standard in the hundreds of elbows they have lined in this manner. Occasionally a small pin hole will be left in the welding bead. The hot oil or gases passing through the elbow gradually work through these minute holes, building up a coke deposit behind the liner. Eventually, as this deposit builds up more and more, it begins to force the liner away from the surface of the elbow, forming a blister. Once the blister is detected in a regular inspection, however, it is a simple matter to cut out that portion of the liner and weld in a new piece.

None of the elbows lined by Standard in the past five or six years has yet required replacement or relining. Thus the economy of this procedure appears to be proven on the larger sizes at least, which are considerably more expensive to replace than the smaller ones.

Corroded pipe flanges are another item which Standard has been successful in salvaging and putting back into service. The faces of these flanges are sometimes subjected to severe corrosion conditions, especially when they do not butt up flush against the adjoining surface, leaving a slight space into which the hot oil and gases can penetrate.

Normally, when the faces of these flanges had corroded beyond allowable limits, the flanges would be scrapped. But now Standard's maintenance department chucks them up in a lathe and machines off about ⅛ in. of the corroded face. The surface is then built up again by welding with 18-8 stainless steel rods and machined smooth. See Fig. 5). If the flange has a groove in the face for inserting a solid ring gasket, that also is cut back, built up with welding, and re-machined.

This salvage operation, of course, isn't limited to pipe flanges. Any fitting (ell, tee, valve) with a flanged face can be put back into useful service by this method. But pipe flanges are the easiest to handle in the lathe because of their symmetrical shape.

Up to the present time, Standard has been refacing flanges only after they have become corroded. But the results they have achieved in longer life have been so satisfactory that they are considering facing new flanges with an 18-8 welded surface even before they are put into service.

Latest development coming out of Standard's maintenance department is in connection with header boxes. In the past, Standard has experienced considerable difficulty because of the corrosion of the seats and plugs in these boxes. Depending upon the type of crude being run and operating conditions, they might last anywhere from one to four years before they had to be repaired.

Most troublesome problem, however, was in renewing the seat. This work had to be done in the field, since it is impractical to remove the header box and take it to the shop. The operation requires welding new metal onto the worn seat (after grinding it clean), and then finishing it off with a tapered reamer, powered by a portable, air-driven motor.

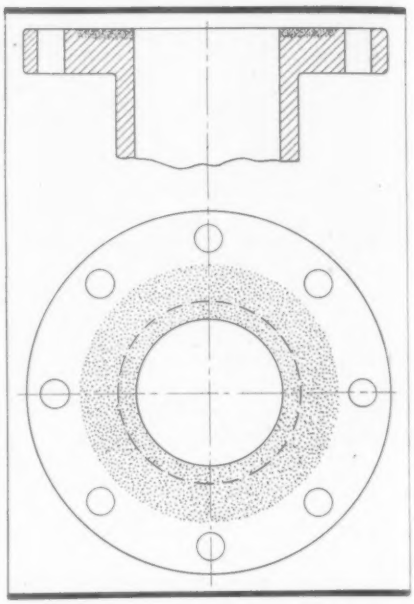


Fig. 5—Corroded pipe flanges are salvaged by cutting ⅛ in. off the old surface, building it up by welding with 18-8 welding rod, and then machining the face smooth. Dotted area in sketch above indicates corroded portion replaced by welding

The procedure is time-consuming and inefficient. It takes from two to three hours to build up and machine a new seat. In some cases the welding might be a little light in one place or an air pocket might have formed, requiring the entire job to be done over. Or the reamer, just when the job was about finished, might start to chatter, giving a rough surface or cutting too deeply. And again the job will have to be done

Fig. 4—The six sections making up the true radius portion of the liner are tack welded together, leaving the one joint or seam along the back open. The mechanic is holding one of the two sections which take care of lining the straight portion of the ell

Fig. 6—Removable seat for header box. The left port already has the new seat inserted, while the machinist is holding the seat which has been prepared for the right port. Note how the old seat has been cut out

over. These problems were exaggerated when experienced welders and machinists began to be scarce.

To get around these difficulties, the maintenance department developed a removable seat for header boxes. As shown in Figs. 6 and 7 this removable seat is merely a ring with a tapered inside face. It is cut from 4-6% chromoly alloy steel tubing of large enough O.D. and wall thickness to fit the particular size header box being worked on.

The old seat of the header box is cut out to a diameter of about ½ in. greater than the largest diameter of the taper, and about ¼ in. deeper than the bottom of the taper. Standard has built a special flat bottomed reamer with six adjustable inserted teeth for finishing off this cutout, but any standard adjustable reamer would do the job.

The new seat is made to fit this cutout, with the O.D. of the ring being .002 in. oversize to permit a press fit. The I.D. of the new seat is made somewhat smaller than the I.D. of the header box (approximately ¼ in.) so that the ring will overhang the walls of the box sufficiently to provide a grip for removing it when it requires replacement.

Several advantages are claimed by Standard for this removable seat. Once the header boxes have been prepared to take this type of seat, the job of renewing them will be much quicker, with correspondingly less down time. It will usually be only a matter of 45 to 60 minutes to pull out the corroded seat and press in a new one. One maintenance foreman said he expected to save from 1½ to 2 hours on each header in the future. A quantity of the seats can be prepared in advance and kept in stock, since for any size header box they will all be of standard dimensions.

Since the seats can be machined in the shop, it will be possible to hold them to closer tolerances than is now possible when building them up and reaming them in the field. These closer tolerances should make it easier to lap the two surfaces (seat and plug) to get a tight fit.

Still another advantage that may occasionally present itself will be the elimination of the need for moving welding and reaming equipment out into the field just to renew a seat. A small hand-operated expanding tool puller will take out the old seat, and the new one can either be forced into place with a hammer or cooled down with dry ice and slipped into position before it expands.

Although it doesn't have much to do with getting around material shortages, Standard's maintenance department has developed another idea which is proving its usefulness in maintenance work. That's a dimpled piece or "cap" of stainless steel for use in covering rivet heads when relining a pressure vessel. The general shape of such a dimpled cover and the method of fitting it over a rivet head are shown in Fig. 8.

Use of this cap eliminates the necessity of welding metal directly to the rivet head—a practice which, because of the intense welding heat, is likely to loosen the rivet and result in leaks.

These caps are simple to make. Starting with a flat piece of 16 gauge 18-8 stainless steel about 4 in. wide and 8 in. long, the dimple is formed in one end. Standard performs this operation on the steam hammer, using a home-made die to get the required shape. The flat metal just around the dimple has a tendency to pull and pucker up, but these wrinkles can easily be hammered out sufficiently by hand. The right angle bend can be formed in a vise or, if one is available, a small brake.

Many other maintenance methods to get around shortages and bottlenecks have been devised at Standard's No. 1 Refinery. The developments presented here, however, are the most successful ones—and of general enough nature to find application in practically every refinery.

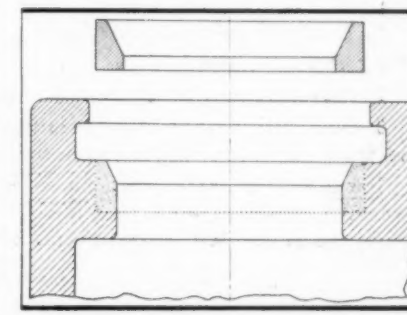


Fig. 7—Cross section view showing section of header box, including old seat. The dotted area of the box will be machined out, so that the new seat (shown above the box) can be inserted

Fig. 8—Dimpled cap for lining over rivet heads in stills

KEEPING UP WITH THE NEWS

New Developments in Scientific, Industrial and Economic Fields Reviewed with Comment as to Their Possible Future Effect on the Petroleum Industry

*By N.P.N. Special Writer**

In common with all industries the petroleum industry faces a postwar era which will be greatly influenced by the multiplicity of technological and economic developments in many fields which have been brought about under the stimulus of the war emergency. Some of these will change the industry's operating technique and bring about the use of new processes and equipment and make obsolete some of the present equipment and methods. Other of these new developments with wider application in the utilization of petrolum products will affect the demand for present products and create markets for new products.

Developments of this nature of course are reported in the news columns of National Petroleum News when first announced. Later consideration and published discussion concerning them, however, frequently provide the material that will help technologists in weighing the possible effect of these new factors on the petroleum industry. It is the purpose of these articles to discuss the new developments in scientific and industrial fields generally as well as in the petroleum industry and report on their possible effect in:

1—Providing some new method or process which may be put into operation in the petroleum field.

2—Providing new products and new uses for petroleum products.

3—Supplying new products or sources for products which may compete with those from petroleum or possibly substitute for them.

The author of these articles is a chemical engineer with one of the large oil companies whose work includes a study of the current technical journals in many fields for new developments of importance to oil companies.

Tailored Lubricant Viscosity

A RECENT new development is credited to the newly-organized California Research Corp., research subsidiary of the Standard Oil Co. of California. It concerns lubricants which are of normal, low viscosity at ordinary temperatures and yet which do not lose their necessary viscosity at high temperatures.

According to a Staudinger equation, the presence of *dissolved* polymeric substances greatly increases the viscosity of a liquid; according to an Einstein equation, a substance *suspended* in a liquid has little effect upon its viscosity. Following this line of thought, a chemist in the Richmond (Calif.) laboratories of the California Research Corp. initiated research on the suspension in lubricating oils of resinous substances of high molecular weight, these being of such a nature that when the oil is heated they depolymerize somewhat (in proportion to the temperature), dissolve in the oil, and check the tendency toward decreasing viscosity. When the oil is cooled, however, they re-form, go back into suspension, and again have little effect upon viscosity.

Through selection of the proper ingredients, it is said that the final lubricating oil can be varied almost as desired. Such oils have obvious potentialities for aviation purposes, where airplanes must sometimes rise from desert temperatures of 120°F. to encounter, in a matter of seconds, temperatures of −75°F. or lower—temperatures which would freeze ordinary lubricants solid. Similarly, ordinary oils which give good lubrication at low temperatures often prove unsuitable for such applications as railway journal bearing lubricants on trains passing from desert heat to mountain blizzards.

This method of solving the problem appears to be of intriguing scientific logic. If the lubricants in question prove to have stable properties in actual use and to be sufficiently inexpensive, they may well find their place alongside the specialty lubricants which other petroleum companies have developed for similar uses.

* * *

Mining for Oil

The petroleum industry, late last year was interested in news concerning Leo T. Ranney's horizontal "oil mining" project, located near Franklin, Pa. A 429-ft. mine shaft, 8 ft. in diameter, had been sunk, at the bottom of which 24 horizontal shafts, each about 2500 ft. long, were being extended. Two of these were completed in December, and, after "blowing in," began production at an initial rate of 33 b/d. Vertical wells in the vicinity are said to average only 0.1 b/d.

Another oil mining project, of a different type, is now in progress in this region. Sponsored by John B. Hawley, Jr., and his Northern Ordnance, Inc. (a subsidiary of the Northern Pump Co.), a 12-ft. square shaft, 700 ft. deep, is being drilled about 12 miles south of Titusville, Pa. Tunnels will be drilled from this shaft under the oil sands, the impervious cap rock below them serving as roof for the tunnels. These tunnels will be sufficiently large to permit the entry of workers who will drill closely-spaced holes upward into the oil-bearing sands, from which the oil will be obtained by vacuum or, perhaps, air pressure.

Such a venture is admittedly an expensive one, a fact which has kept down the number of these enterprises to date. With production capacity far ahead of demands, petroleum producers in prewar days showed little interest in schemes of this type. However, other methods of oil mining have been tried abroad, often involving bringing the oil sands to the surface where oil is extracted by heat or steam. The latter methods resemble some of those proposed for extracting oils or tars from the tar sand deposits of Northern Alberta, Can. However the methods of Ranney and Hawley are not applicable to deposits of this type, since Athabaska tar sands contain bituminous material of a solid or semisolid nature, not oil as such.

With domestic reserves and production capacity as matters of popular as well as industry-wide interest, however, such schemes as oil mining appear much more practical than they did in the past.

* * *

Suspensoid Catalytic Cracking

When Wright W. Gary, President of the Filtrol Corp. described the Suspensoid catalytic cracking process early in 1943, refiners learned that a process had been developed by which thermal cracking equipment might be converted to a form of catalytic cracking by injection of a finely-divided, clay-type catalyst

*The author is a chemical engineer on research staff of one of the oil companies.

into the feed and subsequent separation of the catalyst from the tar. At that time, Mr. Gary stated that economically reclaimable, low-cost catalysts were prime requisites for the process, since catalyst costs above 2 to 3c per lb. would make installation of expensive revivification apparatus a necessity.

Process requirements were said to be on the order of 10 pounds of catalyst per barrel of charge stock. Where regeneration is desired, furnaces of the Harshaw, Nichols-Herreshoff, or similar types were said to be applicable. Clean, low-sulfur gas oils are the required feed stocks, and at that time Mr. Gary mentioned process conditions of 200-250 psi gauge and 925-950°F. Lead susceptibilities were said to be about half way between those of thermally- and catalytically-produced gasolines, with isoparaffinic, isoolefinic, and aromatic hydrocarbons present in large quantities.

Imperial Oil, Ltd., of Sarnia, Ont., is known to be operating four tube-and-tank, high-pressure thermal cracking units on this process, charging a mixture of gas oils and heavy naphtha made into a slurry with clays of 100-mesh and finer. Coil temperatures of 1040°-1060°F. are used, with pressures of 400-500 psi. A cracked gas oil is used for quenching at 750°F.

The four tube-and-tank units were originally designed to have a total gas oil charging capacity of 17,000 to 18,000 b/d and to operate at temperatures between 900°-1000°F. with an outlet pressure of 1000 psi. Coil erosion with Suspensoid cracking is said to be very little greater under present operating conditions than normal operations under the conditions for thermal cracking.

The catalyst used is spent Filtrol obtained from the clay-contact lubricating oil plant at Sarnia. Only two pounds of clay per barrel of feed are used at present, much less than the amount mentioned in 1943 by Mr. Gary. Catalyst regeneration is not practiced at present, chiefly because Imperial was unable to obtain war priorities for the necessary equipment. It is thought that a small unit operating on a modification of fluid-catalyst type regeneration will be sufficient at Sarnia when equipment can be obtained. Regeneration is said to be necessary for economical operation, especially for plants without supplies of spent clay from clay-contact lubricating oil plants.

Typical gasoline yields of 52.3 to 58.6% of 400°F., 10-lb R.V.P. gasoline are mentioned, the higher figure including nonselective polymer from C_3-C_4 gases containing over 50% of olefins. The A.S.T.M., clear, octane numbers of these gasolines were 73.2 and 75.5, respectively, with clear Research '39 octane numbers of 82.0 and 85.1. With 3 cc of tetraethyl lead, Research numbers of 91.4 and 93.2 were obtained. These figures compare with the following data for thermal cracking and reforming, the latter figure again including nonselective polymer: gasoline yields, 56.1 and 58.3%; clear A.S.T.M. octane numbers, 65.4 and 66.6; clear Research '39 octane numbers, 71.0 and 72.6; and Research numbers with 3 cc of tetraethyl lead, 84.8 and 85.6.

Much experimentation remains to be done after the war on product quality and optimum conditions for maximum yields, it is said, since the urgent demand for aviation and other fuels has more or less frozen operating conditions at their present satisfactory figures.

It can be seen that the Suspensoid process is one which has proved of merit during the war in aiding certain refiners who lacked catalytic cracking equipment to raise the octane numbers of their gasoline produced. When the costs of operations become clearly established, it will be time to evaluate the process in regard to its postwar value to possessors of thermal cracking equipment.

° ° °

Natural Gas Resources

The reserves, production, and uses of natural gas have always been pertinent topics to the petroleum industry, since natural gas and petroleum are often (but not always) found together. An even closer alignment has recently become apparent with the disclosure that numerous petroleum companies are contemplating the postwar production of hydrocarbon products from natural gas by use of the Synthine (Fischer-Tropsch) process.

Under these circumstances, some recent estimates of natural gas reserves appear highly interesting, especially since they indicate far larger resources than have hitherto been disclosed. Lyon F. Terry, second vice president of the Chase National Bank, crystallized these estimates when he recently stated that future gas discoveries should be at least as large as resources discovered to date, which total approximately 200 trillion cu. ft. Known reserves at this time are estimated at 110 trillion cu. ft., hence a future supply on the order of 300 trillion cu. ft. is indicated.

It may be calculated that the 300 trillion cu. ft. of estimated reserves would be capable of being converted into 30 billion bbl. of synthetic gasoline, at 10,000 cu. ft. per barrel of gasoline. This figure, of course, is highly fictitious, since natural gas is too valuable a raw material in its own physical state to consider restricting present and future economic uses. Nevertheless, natural gas appears to offer the cheapest starting point for the production of a synthetic petroleum, and several oil companies may build and operate plants in the postwar period, possibly at first for the production of specialized petroleum products instead of gasoline.

Later, as crude petroleum prices rise, actual production of gasoline will probably become economic, but it does not appear likely that any such figure as 30 billion bbl. will ever be produced from this source. Even three billion bbl. might seem an optimistic guess, and, since this figure would be only enough to meet demands of prewar magnitude for a few years, it would be unwise to consider natural gas resources as an important supplemental reserve to petroleum.

Nevertheless, natural gas is an important raw material in its own right. G. G. Oberfell of the Phillips Petroleum Co. recently told the O'Mahoney Senate subcommittee, which was investigating synthetic liquid fuels, that the annual production of natural gas, which approximates three trillion cu. ft., on the basis of 0.60 specific gravity weighs as much as 488 million bbls. of 36° A.P.I. crude oil (72 million tons). On a Btu basis, "the annual production of natural gas is nearly 40% of the crude oil production and about 25% of the bituminous coal production"; at 5c per mcf, "this compares with 36° A.P.I. crude oil at 27c per bbl. at the well and bituminous coal at $1.09 per ton f.o.b. cars at the mine tipple."

According to Mr. Terry, present production exceeds four trillion cu. ft., with 3.3 trillion cu. ft. of this being marketed. Consumption after the war, however, will probably fall to approximately prewar levels at least for a few years.

° ° °

Steam-Powered Airplanes

Fantastic as the idea might seem, it has recently been reported[1] that a Chicago inventor, Louis C. Trosky, and his associates have completed "99 per cent" of the engineering of a steam airplane engine which may enable airplanes to fly "farther, faster, higher, and cheaper than is possible with even the most powerful internal combustion gasoline engines now known."

Fuel oil is used to heat the boiler, which is composed of many small tubes. Oxygen for combustion of the fuel oil at high altitudes is said to be provided by the decomposition of a

[1] *Business Week*, No. 768, 20 (May 20, 1944).

portion of the exhaust steam, the remainder of which is condensed for reuse. It is claimed that the water reserve need be no greater than the reserve of lubricating oil needed for gasoline engines of the same output; very little lubricating oil itself is needed, for the steam engine has only approximately 6% of the moving parts of a comparable gasoline engine.

Steam pressures of 3600 psi are obtainable at high altitude according to the inventor, and a steam head of 600 psi can be obtained in two minutes from a cold start. Mr. Trosky predicts that planes using his engines will be able to reach an altitude of 50 miles, as compared with the present ceiling of about 45,000 ft. for gasoline-powered planes. Steam planes, with practically no design changes other than the installation of steam engines inside the wings, are said to be 100 to 150 mph faster than comparable gasoline-powered aircraft.

Operating costs for the steam engines are said to be 12% of those for comparable gasoline engines, with engine lives 10 to 20 times longer; production cost is expected to be about half. Mr. Trosky, on the basis of 800 flying hours in steam-powered planes, claims that such planes are easier to operate because of the simpler controls needed.

Many of these quoted figures seem almost unbelievable, and further and more technical data will be required before the petroleum industry could regard the idea of such planes in a completely serious light.

The war has brought into the limelight a number of threats to continued use of the present high-compression, high-octane-gasoline-requiring aviation engines. In the years which will follow the war, it is not at all impossible that jet propulsion, steam, Diesel-powered, and gasoline-powered engines will fight it out for supremacy, with the probability that some use will be found for *most* of these types. The whole interrelated problem is of definite interest to the petroleum industry which will supply the fuels to be used, be they fuel oil or 100+ octane gasoline. It is also of interest to the nation as a whole, which will see better, cheaper, and more versatile airplanes produced as a result.

o o o

'Alky-Gas'

According to indications, the nation again seems fated to fall heir to another wave of propaganda concerning the use of alcohol as a motor fuel, at least in blends, advanced this time with the argument that the compulsory use of 5 to 20% of alcohol blends will be of assistance in extending our petroleum supplies, as well as in providing the farmer with a market for his surplus crops—if any. This propaganda will probably increase if alcohol, as is likely, fails to hold its place in the postwar synthetic rubber picture, chiefly because of too-high costs for alcohol-butadiene as compared with petroleum-butadiene.

Zealous proponents of "alky-gas" will probably be taken aback by a recent report of the U. S. Tariff Commission[2]. In the "conclusion" of this report, prepared for use of the Committee on Ways and Means of the House of Representatives, appears the following paragraph (italics inserted):

"Proposals for Government measures requiring the admixture of a certain proportion of alcohol with gasoline in motor fuel, a practice common in various foreign countries *where conditions differ greatly from those in the U. S.*, have hitherto failed of enactment. The quantities of alcohol required to effect even a comparatively small conservation of petroleum would be enormous. If an admixture of only 5% of alcohol with motor fuel were required, this would involve the annual consumption of more than one billion gallons of alcohol, or about 10 *times* the total prewar consumption for all purposes. If, with a view to a substantial conservation of petroleum, the admixture of as much as 20% were required, the quantity of alcohol would be between four and five billion gal."

The food for thought in this statement is not only the sheer magnitude of the figures but also their implications in regard to agriculture. The Tariff Commission's report goes on to say that:

"The capacity of the U. S. to produce corn and wheat is great. In the course even of a few years, if the demand warranted it, the normal output could doubtless be increased by several hundred million bushels without interfering much, if any, with other crops. It is doubtful whether during the immediate postwar years even such an expansion would make great quantities available for alcohol in addition to the probably abnormally large domestic and foreign demand for grain as food for human beings and animals. Later on, however, the possibilities of these grains, especially corn, for alcohol would probably be much greater.

"It is probable, however, that for the U. S. to produce quantities of alcohol sufficient to satisfy any large part of its motor fuel requirements would necessitate an increase of such dimensions in agricultural output as to overreach economic limits."

While the prolific vegetation of tropical regions might provide fermentable plants to produce alcohol in sufficient volume for automotive purposes, this is an extraneous factor in considering "alky-gas" production as a boon to the American farmer. When it is considered, also, that prewar alcohol from domestic corn cost about 27c per gal. to produce, minus overhead and profit, and that the wartime use of wheat has run costs from many alcohol plants to as high as 75 to 80c per gal., it can be realized that whatever profits would accrue to the farmer would come from the pockets of the entire nation, which would be forced to pay the additional several cents per gallon for its automotive fuels. The farmer himself would not profit greatly, for he must sell his grains at wholesale prices and then pay the retail difference in cost for the billions of gallons of gasoline consumed annually for agricultural purposes.

The whole story of power alcohol was succinctly summarized in an A.P.I. booklet[3] in 1940; although a few statistics are now outdated, it remains the very best reference on the subject. Technical considerations, disregarded here, are discussed in this booklet; a report on more-recent investigations was made in 1942 by the Iowa Engineering Experiment Station[4].

o o o

Alcohol from Wood Wastes

A sidelight to the subject of alcohol from forest and farm products may soon be clarified by the commercial operation of two alcohol plants, one at Springfield, Oregon, using waste wood chips and sawdust, and the other at Bellingham, Washington, using waste sulfite liquors from paper pulp manufacture. The plants are scheduled to cost $2,247,000 and $990,000, respectively, and to have capacities of 4.1 million gal. and 2 million gal. per year.

It is said that between 40 million and 60 million gal. of alcohol per year could be produced from waste sulfite liquors in plants located at the 35 wood pulp mills in the U. S. which have a daily capacity of 100 or more tons of pulp, with an additional 50% of this potential available in Canada. There is said to be enough sawmill waste available to produce at least 500 million gal. of alcohol per year at the larger sawmills; the actual figure may be nearer 100 million gal. (recently mentioned by WPB Chairman Donald M. Nelson), or even higher.

Cost estimates for both processes

[2] "Industrial Alcohol," United States Tariff Commission, Washington, January, 1944.

[3] "Power Alcohol, History and Analysis," Committee on Motor Fuels, American Petroleum Institute, Chicago, 1940.

[4] Paustian, R. G., "Road Tests of Automobiles Using Alcohol-Gasoline Fuels," Iowa Engineering Experiment Station Bulletin 158, Ames, Iowa, 1942.

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are so varied and qualified as to be almost unreliable; they range from 10 to 50c per gal., the lower figures admittedly being without consideration of overhead and amortization, as well as profit. If costs of 20c per gal. can be realized, as is frequently claimed, alcohol from these processes will be definitely competitive with that from molasses, although still not competitive with alcohol from petroleum.

The final status of alcohol from sawmill wastes will depend upon "a market for lignin, rather than its use as fuel, since its sale at even 1c per pound will reduce alcohol costs by 10c per gal."[5] This is the case because 650 pounds of lignin are obtained per ton of dry wood waste, along with about 52 gal. of 190-proof alcohol. "Wood must be cheap, since at $2 per dry ton delivered, it probably represents over 60% of the raw material costs."[5]

Large quantities of lignin are also obtained as a co-product from the use of waste sulfite liquors, although this lignin is chemically different and is said to be of lower grade. For both processes, the economic disposal of lignin will play a large part in final success or failure.

It would be valueless to speculate further on the significance of these processes until their economics are better proved. Politics and wartime economics are both involved in the present projects; whether the vested industrial alcohol industry actually has much about which to worry remains to be seen.

° ° °

Postwar Aviation

There seems to be a considerable difference of opinion among economic analysts as to the scope of postwar aviation. C.A.A. officials mention 491,000 private and 9000 commercial planes by 1950 and the need for 6000 airports in the first five years after the war as compared with the present 3000 landing fields. To deflate this prediction, another source[6] points out that, even if the war lasts another two years, only about 200,000 Army pilots will have been trained and graduated, along with a smaller number of Navy and Marine pilots. Even considering that a number of the bombardiers and navigators may have learned to fly before "washing out" as actual pilots, the number of potential civilian pilots from the armed forces will fall short of 500,000 by a considerable margin, and war casualties will reduce the number of those who were trained.

The CAA has estimated that the direct prewar flying costs for small planes averaged $1.80 per hour and fixed overhead costs average $840 per year. At these rates, 100 hours of flying cost $1020, and 500 hours cost $1740. While these costs will undoubtedly be lowered, and joint ownership of planes will reduce the per capita burden of fixed costs, it does seem unlikely that there will even be enough trained pilots who can afford such expenses to account for 491,000 private planes by 1950.

As regards the consumption of aviation gasoline by private planes, Paul Ryan, chairman of the recently disbanded P.I.W.C. Postwar Readjustments Committee, recently stated that even 50,000 pilots operating their planes 200 hours per year would use less than 5000 b/d.

Mr. Ryan says that aviation industry executives believe that the postwar demands for aviation gasoline for commercial purposes will not average more than 25,000 barrels per day for five years after the end of the war. He states that 700 32-passenger planes making twice the number of prewar trips per plane could carry all prewar Pullman passengers and yet consume only 20,000 b/d and that 50,000 barrels of aviation gasoline per day would power enough planes to carry, in addition, all the mail and all the express carried by the railroads in 1939.

If the Army and Navy retain an air force of 10,000 planes, operating them 200 hours per year (many times the number of prewar military planes and twice the prewar usage), Mr. Ryan states that less than 50,000 b/d would be required for this purpose. From all these figures he concludes that the maximum civilian and military consumption in the predictable postwar period will not exceed 75,000 to 100,000 b/d.

While these estimates spell "bad news" to persons who would like to see a continued aviation use of the more-than-400,000 barrels of aviation gasoline now being produced each day, they do not mean that aviation has not taken a long stride forward during the war. Aerial passenger traffic is certain to increase greatly, and cargo carriage will rise to unpredictable heights. All that is unfortunate is that certain sources have led the public to believe that the postwar air will be so full of planes that the birds will have to fight for room, without mentioning the fact that for this to happen some aerial Huey Long would have to put two airplanes in every private hangar and install a free gasoline pump alongside. Aviation has grown and will continue to grow, but the petroleum industry must view it as a market from the standpoint of economics, not desires.

[5] Faith, W. L. and Hall, J. A., *Chemical and Engineering News* 22, No. 7, 525 (1944).

[6] Anon., *Modern Industry* 7, No. 5, 92 (1944).

Republic's 100-Octane Plant

(*Continued from p. R-416*)

of refinery operations, once drove a truck delivering coal.

Mr. Robinson's first job with Republic, he said, was as a clerk in the office at $10 a week.

"As this new plant goes on stream", said Mr. Robinson, "we are all called upon to put forth every ounce of effort for your sons and daughters, brothers and husbands who are risking all on the fields of battle, that we may continue to work, to prosper and to enjoy together the fruits of our labor in a democratic world at peace."

The Texas City refinery of Republic Oil Refining Co. was started in 1931. The site was selected because of its nearness to a crude supply and also because of its location on a deep water harbor. It is convenient to the Mississippi Waterway, by which refinery products are transported to that part of the company's distribution facilities in and around Pittsburgh, its headquarters. The first unit started was a Struther-Well topping unit and before this was completed the plans were supplemented so that a cracking and reforming unit could be built, together with two treating units. In 1932 the South Tank Farm was purchased and in 1933 tetraethyl lead blending facilities were installed and additional boilers constructed.

In 1935 the No. 2 Topping Unit was built and more tankage and an additional cracking furnace erected, followed by a vapor recovery system. The following year more tanks and equipment were put in and an aviation gasoline stabilizer and a lead aviation gasoline blending plant. In 1937 the No. 3 Topping Unit was built with the necessary auxiliary equipment.

This required additional cracking capacity, so Frick-Reid Supply Corp. was awarded the contract for the No. 2 cracking unit, which was put into operation in 1940. This was followed by a fourth topping unit. In 1942 the construction of the Defense Plant of five units was started.

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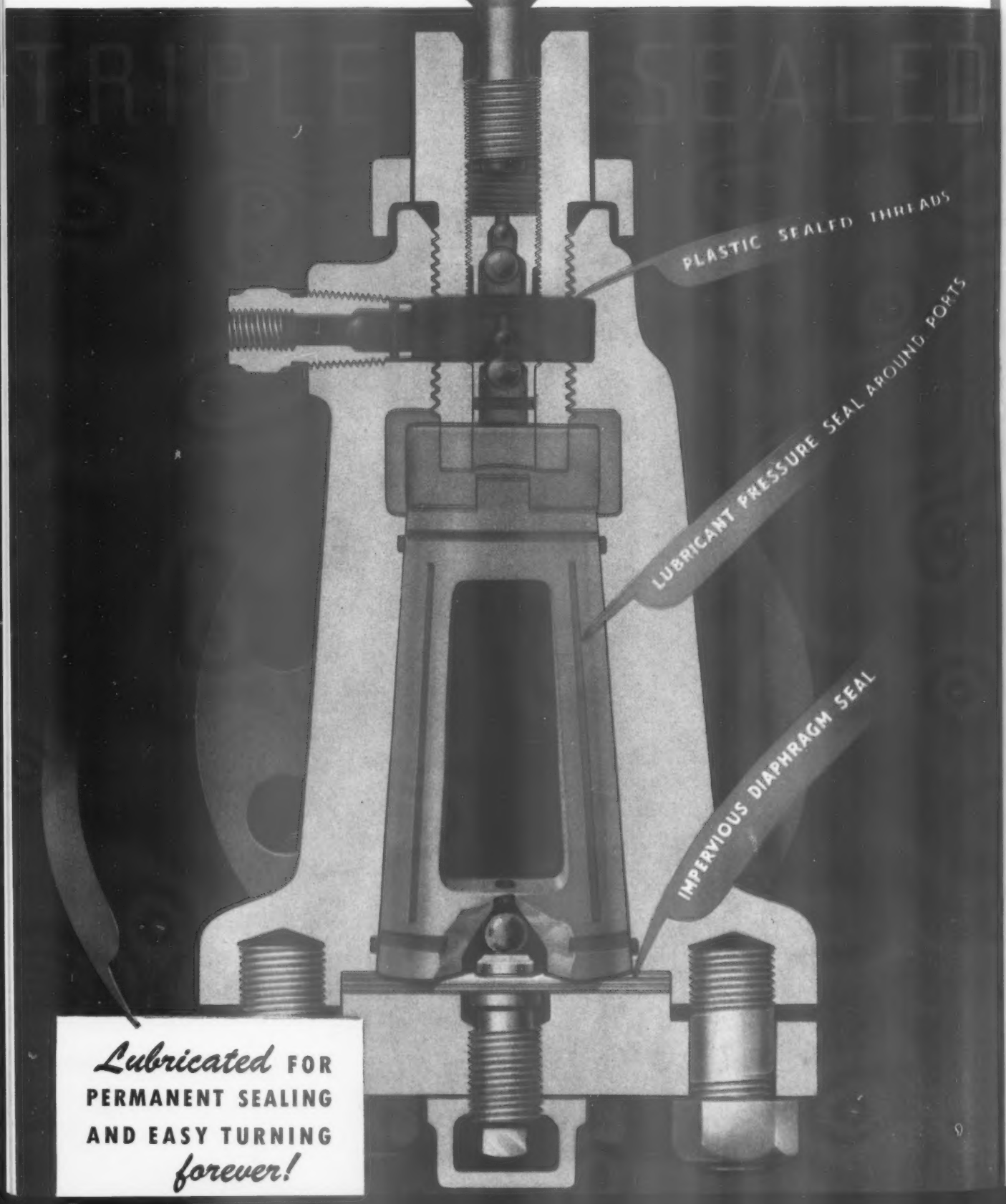

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The Importance of Natural Sulfur Compounds and Role of Peroxides In Oxidation of Lubricating Oils*

New data assign to natural sulfur compounds present in finished oils the major role in maintaining the stability of the lubricant.

The hydrocarbon fraction of refined lubricating oils is shown to consist of naphthenes in admixture with homologues of benzene and naphthalene. By removing natural sulfur compounds without appreciably affecting other constituents, this hydrocarbon fraction is shown to possess negligible resistance to oxidation. Thus, the few percent of natural sulfur compounds present in a finished lubricating oil appear to determine the oxidation characteristics. This control of stability is interpreted as resulting from the fact that the hydrocarbon fraction oxidizes at a rate controlled by the concentration of organic peroxides, and the latter are reduced by reaction with the natural sulfur-containing inhibitors residual in the refined lubricating stock.

In addition to controlling the rate of oxidation of an oil, the organic peroxides determine the rate of corrosion of bearing metals. Such corrosion is shown to result from the ability of peroxides to convert metal into metal oxide, the latter subsequently dissolving by reaction with acidic constituents developed during oxidation.

*By G. H. Denison, Jr.***

THE importance of a knowledge of the oxidation processes in lubricating oils and the application of this knowledge to the design of improved products needs no discussion. It suffices to say that the various organizations connected with lubricants invest ample manpower and capital each year in the subject, in order to try and cope with the ever-increasing strain of heavy service placed on their oils.

In actual service, the oxidation of a lubricating oil takes place in highly complicated systems. For example in an internal combustion engine, catalysis by metal surfaces and metal soaps as well as complex variations in temperature and oil-air agitation throughout the oil stream markedly affect stability. To investigate the mechanism of oxidation in such a complicated system without adequate knowledge of the oxidation in simple systems does not appear sound. The aim of the present paper is to aid in establishing a basic mechanism of oil oxidation under as simple conditions as feasible in the belief that, when adequate knowledge has been thus obtained, the effect of service variables and catalysts may be dealt with as perturbations on the reactions taking place in simple systems.

Research on the mechanism of oil oxidation even in simple systems is obviously not a precision study. The complexity of the material itself, let alone the complexity of the oxidation of any one chemically pure high molecular weight hydrocarbon forces treatment in terms of generalities. However, if such generalities are made, as, for example, classifying all the oxidation products of one organic class simply as one compound, some surprisingly useful parts of the basic reaction mechanism can be developed. It is in this vein that the following work has been carried out.

Before a discussion of lubricating oil oxidation can be sensibly undertaken, a common picture of the constitution of the oil itself must be established. It is well known that a finished lubricating oil consists of a multitude of different hydrocarbons, which make up anywhere from 80 to 98% of the stock. In addition, there are between 2% and 20% sulfur compounds, .08 to .3% nitrogen compounds and some oxygen compounds. This multiplicity of compounds may so perturb the oxidation of each other as to mask completely any similarity of the oxidation mechanism to those of the pure, low molecular weight compounds in the literature.

Hydrocarbon Fraction

The resistance of oil to deterioration is known to vary with the source of the crude and the treatment it receives. Simultaneously, with this variation in stability the nature of the oil varies both in its major fraction, the hydrocarbons, and in the small percentage of non-hydrocarbons present, such as the sulfur compounds. The most obvious point of attack in studying composition, at least for the sake of oxidation research, consists in determining whether the hydrocarbons or the non-hydrocarbons control the oxidation characteristics. Let us first consider the hydrocarbon fraction.

There are two general methods by which the composition of a mixture such as lubricating oil can be determined, or, more literally, approximated. These methods might be termed analytic and synthetic. In the analytic method, the mixture is separated by physical and chemical processes into its components and these components are analyzed and compared with known substances. In the case of lubricating oils, this process is exceedingly difficult, due to the complexity of the mixture. The synthetic method employs the procedure of preparing compounds similar to those expected to be present in the mixture, and comparing the properties of the synthesized substances and their blends with those of the lubricating oil. This method is simpler than the analytical method, but definite proof of composition is never established. Both of these methods have been applied and excellent reports given by Mikeska[7] A.P.I. Projects 6 and 42, and by many others.

In applying the analytic method to the present problem, the technique adopted at the Bureau of Standards was followed and the finished lubricating oil separated into a series of narrow fractions by solvent extraction, using a Fenske column as described by Mair and Schicktanz[5].

Each fraction was analyzed as follows. The ring analysis devised by Vlugter, Waterman and van Westen[8] was employed to estimate the per cent of different types of hydrocarbon groups —paraffinic, naphthenic and aromatic— present in the base oils and in the fractions produced by the solvent treatment. Since there are many types of aromatic nuclei possible in a lubricating oil, and inasmuch as the type of aromatic nucleus will affect stability, a classification of aromatic fractions was desirable. For this purpose a chart published by Mair, Willingham and Streiff[6] of the Bureau of Standards, was used. These investigators correlated the number of carbon atoms per molecule with the specific dispersion of a large number of hydrocarbons, and were able thereby to classify unknown aromatic bodies.

The result of such an analysis on an SAE 30 oil (oil A)° prepared by moderate refinement of a California naphthenic crude is shown in Table I. Since the quantity of each fraction decreased as the extraction progressed it was necessary after removal of the first 6, to combine the succeeding fractions into pairs, thus fraction 7 is in reality fraction 7

*This paper originally appeared in the May, 1944, issue of Industrial and Engineering Chemistry of the American Chemical Society.

**Standard Oil Co. of California, San Francisco.

°The inspections of oils referred to by letter will be found in Table IV.

plus fraction 8. As is to be expected, the successive fractions decrease in specific dispersion and per cent aromatic rings.

In order to use directly the specific dispersion chart of Mair, Willingham and Streiff, the number of carbon atoms per molecule for each fraction was approximated by dividing the molecular weight by 13.5. Plotting these specific dispersion values for the extracts did not furnish much information on composition. The points on such a plot started close to the alkyl naphthalene line and followed down to that of almost pure naphthenes. Such behavior results from the fact that due to variation in molecular weight and in the nature of the paraffin side chains, the various extracts are necessarily blends of aromatics and non-aromatics rather than pure alkyl aromatics.

Considerably more information on the nature of the extract fractions is obtained if the per cent aromatic rings and specific dispersion are used to calculate the specific dispersion contribution of the aromatic rings themselves. A value for this contribution may be estimated by assuming linear additivity of the effects due to aromatic rings and non-aromatic residues as indicated by the formula.

$$aY + 98.4b = S \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where a = fraction aromatic rings
b = fraction non-aromatics
Y = specific dispersion contribution of aromatic rings
98.4 = specific dispersion contribution of non-aromatics
S = measured specific dispersion of sample

The results of such a treatment are shown in Fig. 1. Fig. 1 also includes the results from similarly analyzing data taken on a Pennsylvania oil (Oil B) and a Gulf Coastal oil (Oil C). The values shown as horizontal lines for naphthalene and benzene were obtained by taking the average of several results calculated according to the above formula from data on known pure homologues. The solid lines on the chart represent the original data for the extract fractions as calculated on a basis of the Vlugter, Waterman, and van Westen ring analysis. The broken lines correspond to values roughly corrected to fit the Deanesly and Carleton[1] ring analysis. That the aromatics present in finished lubricating oils of various origins are fundamentally benzene and naphthalene homologues appears evident. Therefore to evaluate the stability of the hydrocarbon fraction of a lubricating oil, a study of the stability of blends of naphthalene, benzene and naphthene hydrocarbons should suffice.

TABLE I—Hydrocarbon Analysis of California Naphthenic Type Lubricating Oil by Solvent Extraction in Fenske Column

Fractions	Yield %	Specific Dispersion	Carbons Atoms Per Molecule	Aromatic Rings %	Naphthene Rings %	Paraffin Side Chains %
1	3.8	189	20.1	64	18	18
2	3.3	174	21.4	55	15	30
3	2.3	166	22.0	47	18	35
4	2.0	166	22.6	45	20	35
5	1.5	159	22.6	41	23	36
6	2.2	156	23.1	38	23	39
7	3.5	152	23.9	39	23	38
8	3.1	143	24.0	37	24	39
9	3.1	145	24.5	31	28	41
10	2.5	138	24.5	28	30	42
11	2.4	130	26.1	27	30	43
12	2.3	133	25.0	23	35	42
13	2.2	129	23.8	19	39	42
14	2.0	124	25.1	20	37	43
15	1.6	114	27.6	12	41	47
Raffinate	62.1	101	28.7	0.7	44	55
Original Oil	...	120	27.0	15	33	52

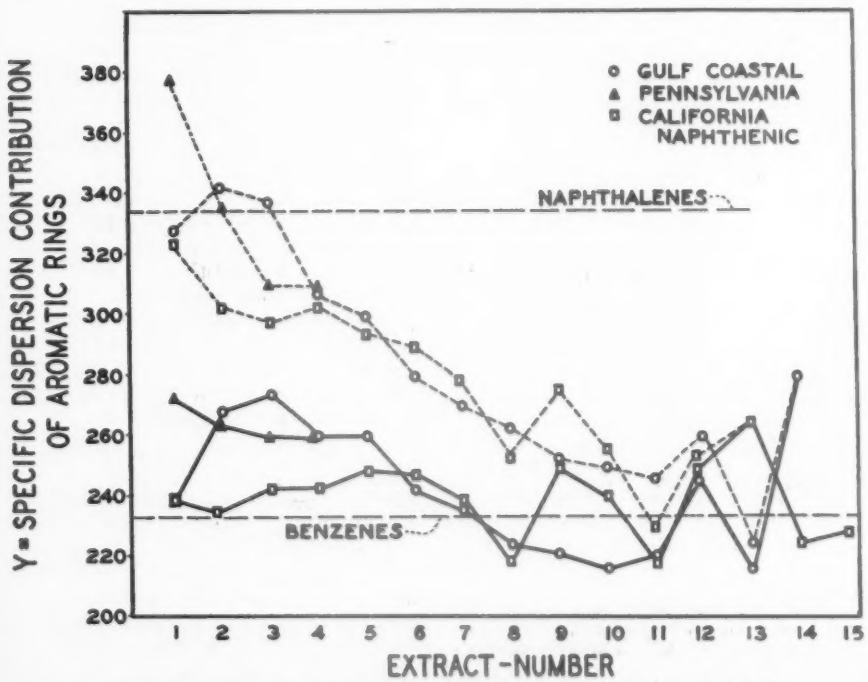

Fig. 1—Characterization of aromatic fractions from lubricating oils

A very excellent treatment of the oxidation characteristics of such lubricating-oil-like hydrocarbons has already been presented by Larsen, Thorpe and Armfield[4] and our own work along this line is in complete accord, hence a discussion of this subject will be omitted here. It suffices to say that alkyl naphthenes including petroleum white oil all oxidize autocatalytically and are extremely unstable as compared to straight lubricating oils. Alkyl benzenes and alkyl diphenyls are also extremely unstable. Alkyl naphthalenes, on the other hand, can be extremely stable, even more resistant to oxygen absorption than the best lubricating oils.

In spite of this extreme stability of alkyl naphthalenes, if an attempt is made to blend them off with naphthenes in such proportions as to obtain an aromatic content comparable to that of lubricating oils, blends are obtained which have stabilities relatively little better than that of medicinal white oil. It would thus seem that in spite of the temptation to give undue credit to the alkyl naphthalenes, the hydrocarbon fraction of a lubricating oil cannot have much to do with its resistance to oxidation. Larsen et al came to the same conclusion.

Since the hydrocarbon fraction of a lubricating oil does not control its stability, an investigation of the next most abundant fraction was undertaken some years ago. An attempt was made to desulfur lubricating oils completely without appreciably changing the hydrocarbon fraction. At first, a simple vacuum distillation from sodium metal was tried. The distillate, however, contained about 90% of its original sulfur and was still stable; in fact many oils so treated increased in stability. One conclusion that can be drawn from this experiment is that natural acidic or phenolic bodies which would be removed by such a treatment play no appreciable part in stabilizing the lubricating oil.

Desulfurization was finally accomplished by contacting the oil for several hours with sodium metal at 500°F. under 200 psi hydrogen pressure. After

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washing and mild clay-treating the oil contained .07% sulfur in one run and .03% sulfur in a check run, a marked reduction from the original .53% sulfur. As indicated by Bromine Number no olefinization occurred. Since such a treatment might otherwise affect the hydrocarbons, the specific dispersion was measured and a Waterman analysis was made. The results of these analyses after so treating this moderately refined naphthenic stock and also 3 other lubricating oils from various sources are shown in Table II. Actually, the drop in per cent aromatic rings as indicated by this analysis is known to be excessive since experiments with synthetic sulfur compounds have shown that the addition of .1% sulfur as a non-aromatic organic sulfur compound gives in general an apparent rise of 1% in aromatic rings.

Thus any apparent decrease in aromaticity can within the experimental error of the ring analysis be attributed to the removal of sulfur compounds. As shown in Fig. 2 every one of these desulfured oils exhibited instability of a degree similar to the white oils. Some question might be raised as to whether in this experiment the difference between the original and treated stock was solely due to sulfur compounds. However, since phenolics have been eliminated by the results of the sodium distillation and since the Waterman analyses and specific dispersions afforded fair proof of an unvaried hydrocarbon content, one is led to believe that natural sulfur compounds are the agents responsible for the stability of straight mineral lubricating oils.

This last fact would seem to be the key to a simplification of the research on lubricating oil oxidation. The problem of oxidation mechanisms would then appear to be best dealt with by first carefully studying the oxidation mechanism of an idealized sulfur-free oil, then to undertake a study of the perturbing effect of sulfur compounds on these reactions.

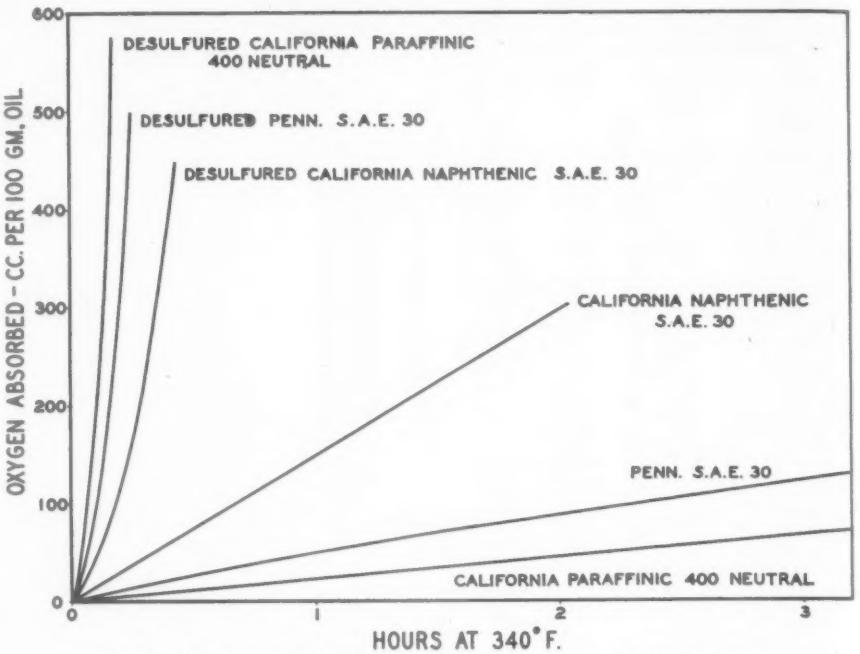

Fig. 2—Effect of desulfurization upon stability of lubricating oils

Dependence of Oxidation Rate on Peroxide Concentrations

In the present report no attempt will be made to consider more than the initial steps of the oxidation reaction since this suffices to depict the role of the sulfur compounds. If the oxidation of a highly refined oil is continued beyond the initial stage and into the region where the oxidation rate degrades to a slower linear reaction, results as shown in Fig. 3 for oil F are obtained. The absorption of oxygen (as measured in the Dornte[2] type apparatus) proceeds at an ever increasing rate up to a point of inflection, and thereafter slows down, eventually approaching a relatively constant rate. Simultaneously the peroxide concentration as measured by Wheeler's[9] method rises to a maximum which is reached as the oxygen absorption curve passes its inflection point. The peroxides then rapidly decrease, eventually tending toward a steady state. Such behavior suggests that the rate of oxygen absorption is possibly proportional to the peroxide concentration. To test this possibility, namely, that

$$\frac{d(O_2)}{dt} = -k\,(\text{peroxide}) \quad \ldots\ldots\ldots (2)$$

it is mechanically simpler to prove the integrated relation

$$(O_2) = -k \int (\text{peroxide})\, dt \quad \ldots\ldots\ldots (3)$$

since a planimeter may then be applied to integrating under the measured peroxide curve. Integrating and evaluating k from one of the known oxygen absorption values, the curve drawn through the oxygen absorption points of Fig. 3 was obtained, thus establishing the validity of Equation 2. Moreover, it is known that peroxides catalyze the oxidation of these oils. These two facts indicate that the rate of oxidation is here determined by the concentration of peroxide, the latter apparently being a fundamental part of the chain reaction which constitutes the oxidation. Such being true, the addition of any agent which will reduce peroxide concentration under the conditions of the oxidation will consequently reduce overall oxidation. This action is true of those compounds commonly called inhibitors. An exception to the last statement might be made for those agents which, by virtue of an ability to poison catalysts external to the system (such as metals or metal soaps), have unfortunately come to be called inhibitors.

Relation of White Oil To Typical Lubricating Oil

Since the first step in the oxidation reaction is controlled by peroxide, those oils, for example medicinal white oil, which because of a lack of natural inhibitors can develop high peroxide concentrations will also develop high oxidation rates. Those lubricating oils which are rich in natural anti-oxidants, that is agents capable of rapidly reducing peroxide, will not build up high peroxide concentrations and consequent high oxidation rates. The latter statement is only true when the natural anti-oxidants involved are of that ideal type which of themselves have no great tendency to absorb oxygen directly.

Since the natural sulfur compounds have been shown to be the principal anti-oxidants in a finished lubricating oil,

TABLE II—Effect of Sodium Treatment on Composition

Oil Investigated	% Sulfur		% Aromatic Rings		% Naphthene Rings		% Paraffin Side Chain		Specific Dispersion	
	Orig.*	Final	Orig.	Final	Orig.	Final	Orig.	Final	Orig.	Final
Moderately Refined Calif. Naphthenic Oil SAE 30 (Oil A)	0.53	0.07	15	14	33	33	52	53	120	121
California Paraffinic 400 neutral (Oil D)	0.22	0.06	1	1	27	27	72	72	106	...
Gulf Coastal Lub. Oil, SAE 30 (Oil C)	0.20	0.04	10	7	32	35	58	58	117	115
Penn. Lub. Oil SAE 30 (Oil E)	0.10	0.01	7	4	16	20	77	76	111	110

*Original.

it is interesting to investigate the reaction between these bodies and peroxide by observing the rate of peroxide decay when blends of a finished lubricating oil having a sulfur content of .53% (Oil A) and a peroxide-rich preoxidized white oil are heated in the absence of air. Fig. 4 shows the result of an experiment wherein a mixture of 88% oxidized white oil and 12% of a finished lubricating oil were heated at 250°F. under nitrogen. The reduction of peroxides by reaction with components of the lubricating oil is obvious. When such a test was carried out adding various concentrations of the lubricating oil, the results of Fig. 5 were obtained. Here $\log_e(P_o/P)$ rather than P is plotted, P_o representing the initial peroxide concentration and P the concentration at time t. For each set of data $\log_e(P_o/P)$ is seen to be a straight line function of time. Moreover, the slope of each line divided by the concentration of added lubricating oil is fairly constant throughout having an average value of .064, indicating the relation

$$\frac{d}{dt}(\text{perox.}) = -.064(\text{perox.}) \times (\%\ \text{lub. oil}) \quad \ldots\ldots (4)$$

Thus the rate of decomposition is directly proportional to peroxide concentration and to the concentration of the natural inhibitor. It would appear then that in the oxidation of a typical lubricating oil, peroxides are formed in the same manner as they are in a white oil, but due to a rapid reaction with certain natural sulfur compounds, peroxide concentrations can only build up to that point at which the rate of formation and reduction become equal. This mechanism, then, in addition to the peroxide reduction by highly oxidized products formed in the oxidation, maintains peroxide at an approximately steady value, the concentration of which will depend upon the rapidity of the oil in question to form peroxide and the efficiency of its inhibitors to reduce peroxide.

Peroxide Concentration Varies

In a sense, then, the peroxide concentration, while the natural inhibitors are still present, is determined by a sort of pseudo-equilibrium between these two rates. In certain oils, this concentration is practically immeasurably low. Since the overall oxidation rate is dependent upon peroxide concentration, this results in a low rate of overall oxidation. In other lubricating oils, the peroxide concentration may be as high as 10 cc oxygen for 100 gr oil or even higher, with a consequently higher overall rate of oxidation. It must be borne in mind that the above remarks apply only to oils which have been given a normal amount of refining. In crude distillates, for example, the concentration of peroxide reducing compounds is exceedingly high. In fact, no appreciable peroxides are evi-

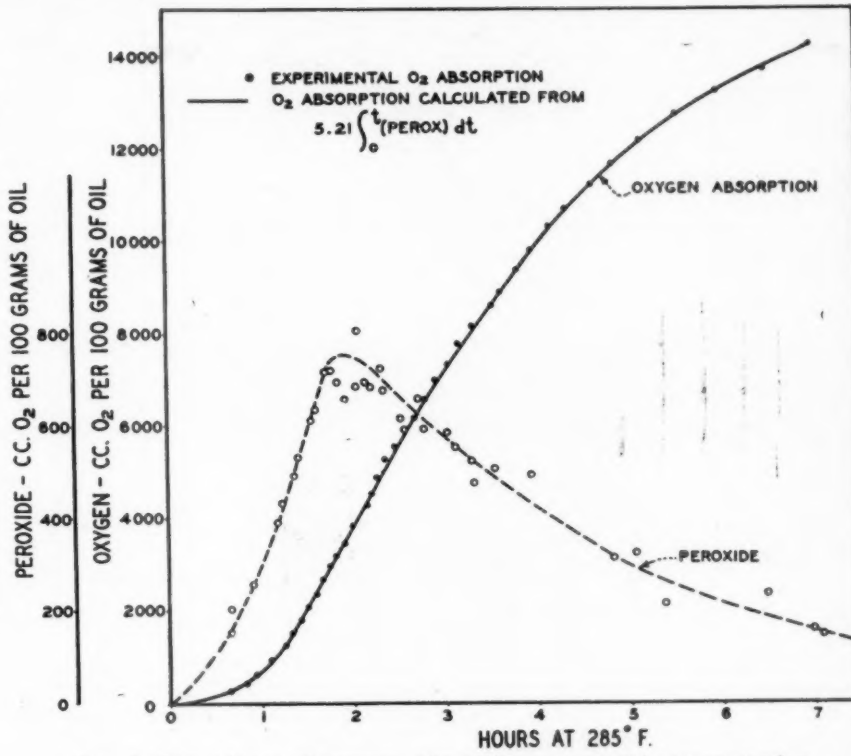
EXPERIMENTAL O2 ABSORPTION
O2 ABSORPTION CALCULATED FROM
5.21 ∫ (PEROX) dt
OXYGEN ABSORPTION
PEROXIDE
PEROXIDE - CC. O2 PER 100 GRAMS OF OIL
OXYGEN - CC. O2 PER 100 GRAMS OF OIL
HOURS AT 285° F.

Fig. 3—Dependence of oxygen absorption on peroxide concentration

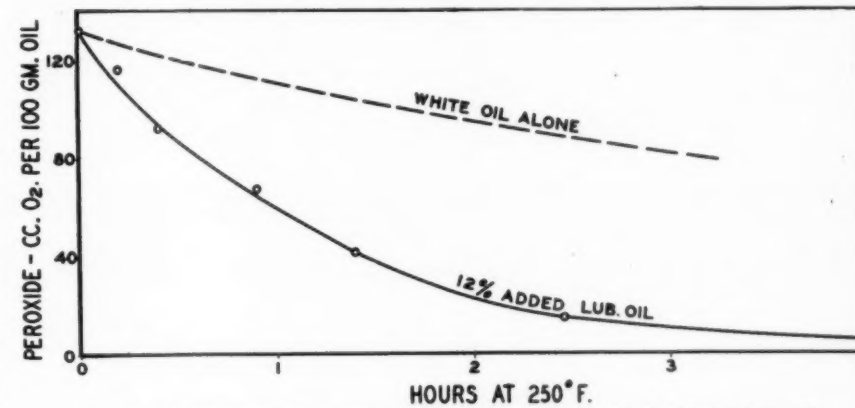

Fig. 4—Decomposition of white oil peroxide by added lubricating oil

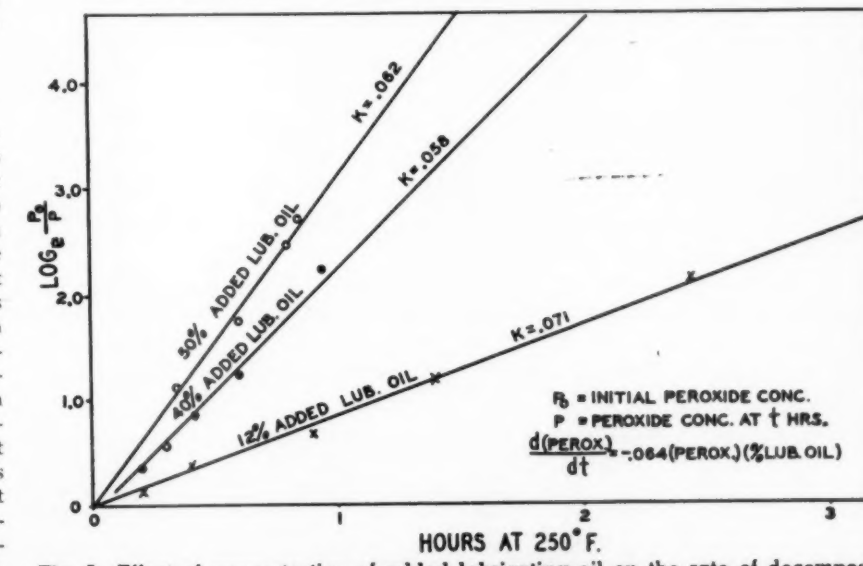

Fig. 5—Effect of concentration of added lubricating oil on the rate of decomposition of peroxides in white oil

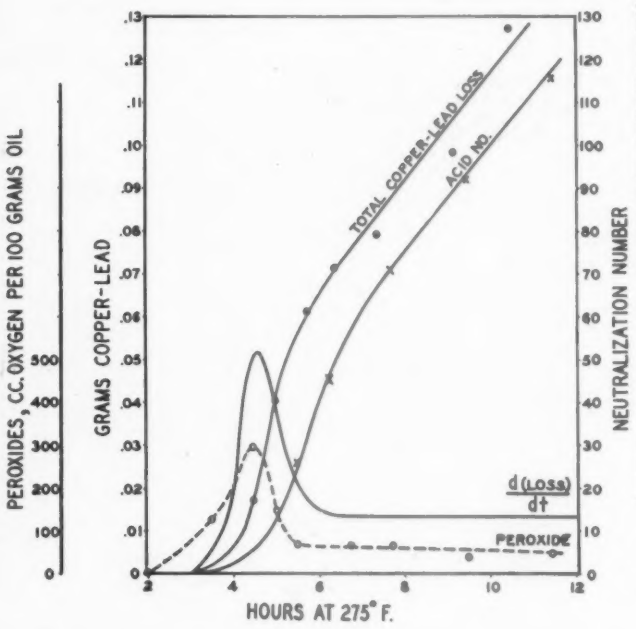

Fig. 6 (left)—Relation of peroxide to corrosion of copper-lead bearing metal

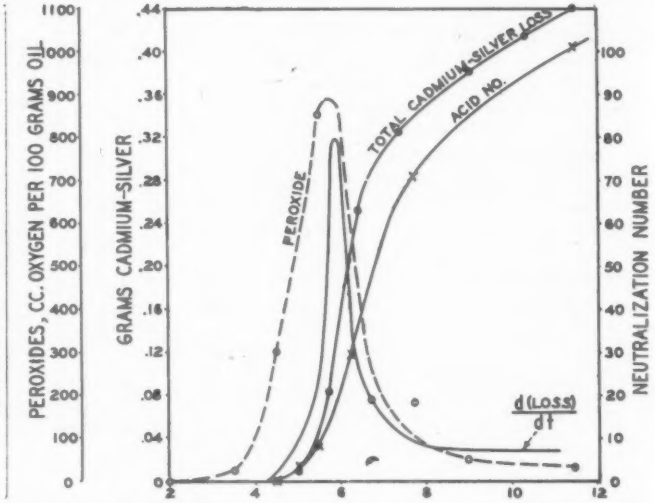

Fig. 7 (above)—Relation of peroxide to corrosion of cadmium-silver bearing metal

dent, yet the overall oxidation rate is exceedingly high. This type of reaction apparently does not involve a chain mechanism, but consists chiefly in the direct absorption of oxygen by exceedingly reactive molecules.

The natural sulfur compounds in a refined oil, in the course of their reduction of peroxides, are themselves oxidized to deleterious compounds. For example, peroxide reduction experiments carried out in the presence of lubricating oil, show a far greater development of resinous compounds than occur in the direct thermal decomposition of petroleum peroxides. What other deleterious agents probably result from the peroxide oxidation of sulfur bodies can be left to the imagination. However, the refiner is forced to choose the lesser of two evils, in that he must maintain sufficient natural sulfur compounds to prevent the development of appreciable peroxides and consequent high oxidation rate, yet must keep them sufficiently low so that what oxidation does occur will not give rise to too many deleterious agents.

Further investigation of the properties of peroxides brings to light the interesting fact that in addition to controlling the rate of oxidation of refined lubricating oils, they also are the agents responsible for bearing metal corrosion. No statement has been made in the literature connecting peroxides with the corrosion of bearing metals. Many articles have been written on the subject of bearing corrosion, and the statement is generally made that acidic products of oxidation give rise to corrosion and yet in all of these articles, attempts to correlate corrosivity with either total acidity or acid strength admittedly failed. Since peroxides were generally known to exist in oxidized oil, it is surprising that their connection with corrosion has not been treated, especially since Engler and Kneis[3] published a paper in 1887 in which they stated that certain metals, particularly lead, in contact with oxidizing turpentine are readily oxidized by peroxides and subsequently by reaction with the acids generated, the lead oxide is converted to a soluble soap.

The application of this reaction in present day bearing corrosion is readily established. Returning to the ideal case of white oil, the following experiment was performed. A sample of oil F oxidized to high acid and peroxide values was freed of peroxide by heating to 250°F. for two hours in the presence of 1% moderately refined oil. This sample was referred to as "Acid Oil." "Peroxide Oil" low in acid and high in peroxides was prepared by washing the oxidized white oil several times with cold aqueous caustic. Table III shows the action at 275°F. and 300°F. of these samples on cadmium-silver bearing metal in the absence of oxygen. It is evident from these data that the "Acid Oil" has a negligible effect upon cadmium-silver, whereas "Peroxide Oil" gave rise to appreciable corrosion. The variation between a maximum corrosion of 1.6 mg. at 275°F. and .0 mg. at 300°F. in the

TABLE III—Relative Corrosivity of Acids and Peroxides

Oil	Temp. °F.	Time in Minutes	Total Loss of Metal (Mg.)	Peroxide Content*	Neutralization Number Mg.KOH/G. OIL
Peroxide-Oil	275	0	. .	421	1.0
Peroxide-Oil		85	8.0	54	. .
Peroxide-Oil		230	12.0	0	2.1
Acid-Oil	275	0	. .	0	4.4
Acid-Oil		85	1.0	0	. .
Acid-Oil		230	1.6	0	3.5
Peroxide-Oil	300	0	. .	413	0.80
Peroxide-Oil		105	13.0	0	1.61
Peroxide-Oil		165	13.0	0	1.62
Acid-Oil	300	0	. .	0	3.7
Acid-Oil		105	0.0	0	2.9
Acid-Oil		165	0.0	0	3.0
Original Oxid. Oil	300	0	. .	443	2.8
Original Oxid. Oil		105	20.0	0	. .
Original Oxid. Oil		165	20.0	0	. .

*Peroxide expressed as cc 0_2/100 Grams of Oil.

TABLE IV—Inspections of Oils Studied

Oil Designation	Grav. °A.P.I.	Flash °F.	Viscosity SSU 100° F.	Viscosity SSU 210°F.	Viscosity Index	Pour Pt. °F.	Color ASTM	Neut. No.	Conradson Carbon, %	Sulfur, %
A	21.3	385	627	56.5	8	—20	3	0.04	0.08	0.53
B	30.3	425	183	45.5	100	5	3	0.07	0.03	0.15
C	21.9	410	585	57.5	34	—10	2	0.02	0.03	0.20
D	29.4	480	424	58.1	90	0	1½	0.03	0.02	0.22
E	28.2	445	530	66.4	102	20	6	0.04	0.48	0.10
F	27.0	395	343	61.0	. . .	—25	water white	0.01	0	0.03
G	26.8	405	363	51.3	52	—25	1—	0.02	0.01	0.12
H	29.2	435	342	54.2	93	—15	2½	0.10	0.14	0.18
K	20.2	380	455	50.9	0	—10	3—	0.02	0.06	0.82

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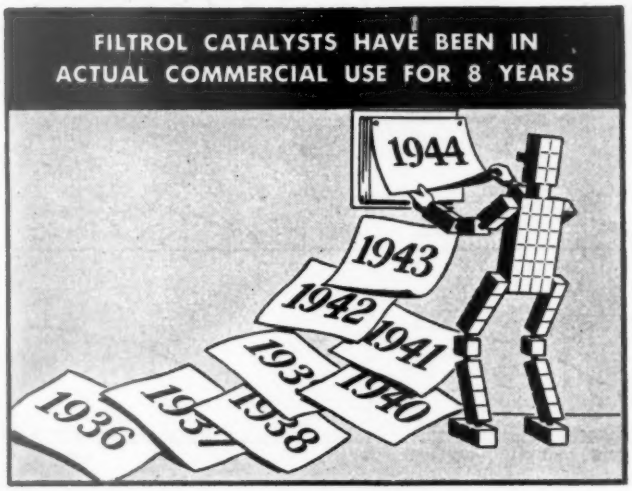

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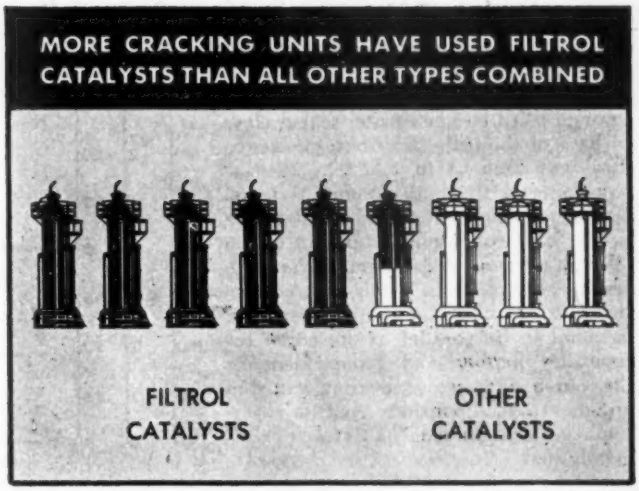

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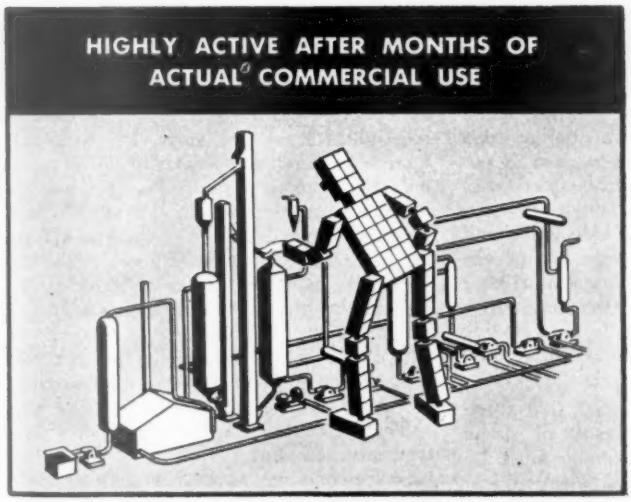

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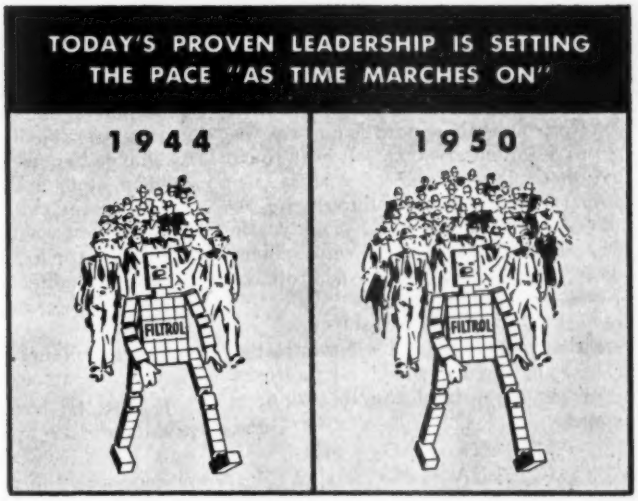

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case of "Acid Oil" is probably indicative of experimental error. It might be remarked, in connection with the above experiment, that lead is not corroded at 340°F. by naphthenic acids which are free from oxygen and peroxide.

A more interesting series of tests consists of determining simultaneously the loss in weight of the bearing metal strips, the acidity, and the peroxide number as a function of time, again using oil F. In these experiments a single strip of bearing metal having an alloy area of 4.8 sq cm in the case of cadmium-silver and 11.6 sq cm in the case of copper-lead was suspended by a glass hook into 200 cc of the test oil. Oxygen was fed in through a fritted glass plate, sealed close to base of the cell. The rate of oxygen flow was such as to maintain at least two-thirds of the bulk volume as foam. Such a rate had been found to guarantee under these conditions, saturation of the oil with oxygen. Figs. 6 and 7 show the results of such tests. The rate of corrosion curve plotted as grams per hour is found to be parallel to the curve for peroxide number and independent of the curve for acidity bearing out the argument that peroxides control corrosion. In fact, the data indicates approximately that

$$\frac{d}{dt}(\text{loss}) = -k(\text{perox.}) \quad \ldots\ldots\ldots (5)$$

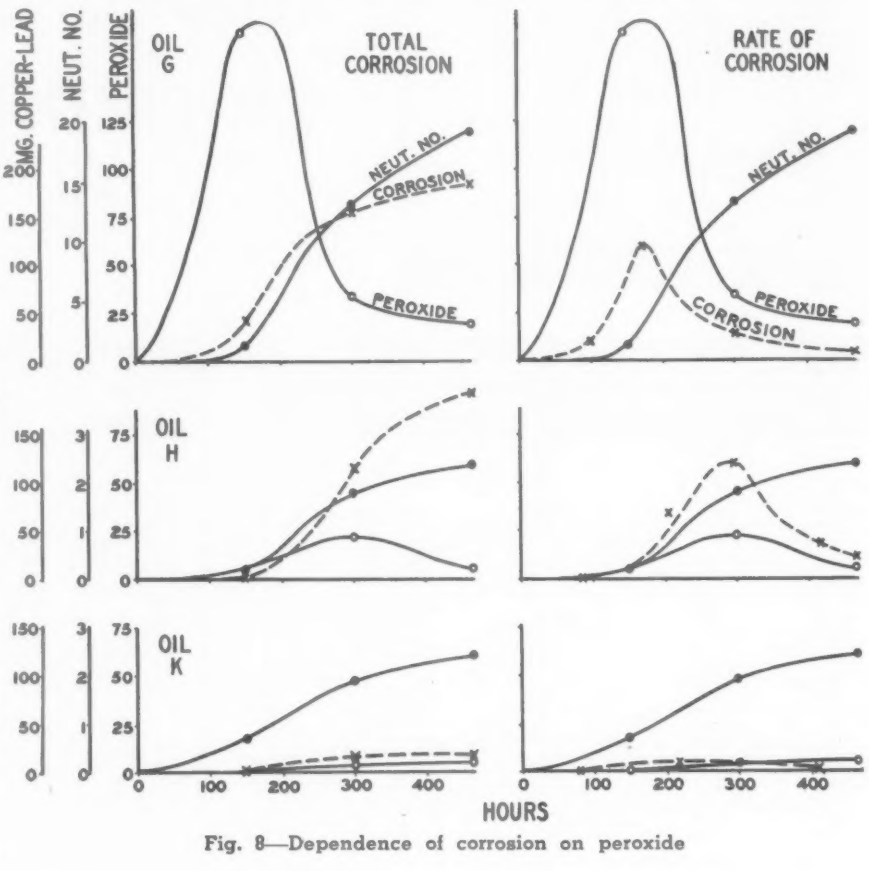


Fig. 8—Dependence of corrosion on peroxide

The parallelism between curves for acidity and for total corrosion lead one to the belief that the rate of acid formation is likewise controlled by peroxide concentration.

A striking example of the overall mechanism of corrosion is afforded by a test similar to the one just described but in which at intervals a pure lead strip was removed for observation. It was found that once appreciable peroxides had formed in the oil, but prior to the development of appreciable acidity, the strip was heavily covered with salmon-colored lead oxide. Then as oxidation progressed and appreciable acidity developed the oxide coat dissolved off and corrosion proceeded. This indicates that at least in highly refined oil, corrosion occurs as a result of the following reactions:

$$M + AO_2 = AO + MO$$
$$MO + HA = MA + H_2O$$

where M = metal, AO_2 = peroxide, and HA = organic acid.

Since these reactions were established in white oil rather than in an actual lubricating oil, it was considered worth while to extend this proof to commercial lubricants. Fig. 8 shows the result of following peroxide number, neutralization number and rate of corrosion as a function of time in a typical strip corrosion test. For convenience in plotting, rate of corrosion is expressed as mg per 100 hours. These experiments were carried out on various commercial samples in a routine strip-corrosion test. The apparatus consisted of glass tubes 2 in. in diameter and 20 in. long immersed in an oil bath, the temperature of which was automatically controlled to 200 ± 1°F. Approximately 300 cc of the oil under test was placed in each tube and air bubbled through it at the rate of 10 liters per hour. Strips of bearing metal were suspended in the oil. Before each weighing, the strips were washed in petroleum ether and carefully wiped with a soft cotton cloth. Although the parallelism between the peroxide curve and the rate of corrosion curve is not absolute, it is sufficient to show that at least within the accuracy of the tests corrosion rate is proportional to peroxide concentration and independent of acidity, providing some acid is present.

It must be borne in mind that these corrosion data are the result of single runs and hence more weight must be placed upon the general agreement and trend than upon the characteristics exhibited by any single curve. It should also be pointed out that the peak on the peroxide curves may be drawn through the experimental points in such a way so as to emphasize better agreement than is shown, but the difference between these curves and the worst possible through the points is not such as to change the general conclusion. The curves for oils H and K possibly explain the case frequently encountered wherein two oils develop similar acidity, yet give rise to markedly different degrees of corrosion. However, it is evident from Fig. 8 that peroxide concentration and the absolute rate of corrosion are not definitely and universally inter-related between widely different oils. For example, as indicated by the curve for Oil G, considerably greater peroxide content causes the same magnitude of corrosion as Oil H, which exhibits much lower peroxide. It is not surprising to find peroxides varying in activity in different oils. Common peroxides are known to vary considerably in activity. No absolute dependence of corrosion rates on peroxide values for different oils is necessary, however, as long as in each separate oil these two are approximately proportional. As long as the second is true, there can be little doubt that peroxides are an appreciable causative factor in bearing corrosion.

This correlation between peroxide concentration and corrosion is not surprising when we remember that by far the greatest class of corrosion inhibitors are agents which will reduce organic peroxides, for example, organic phosphites, arylamines and phenolics. The only corrosion inhibitors which are not peroxide reducing agents have been fairly well established as owing their effectiveness to the formation of protective coatings on the metals.

Conclusions

An attempt has been made to show that the most potent method of attacking the problem of lubricating oil oxidation consists of investigating the mech-

anism in an idealized system representative of the major oil fraction and then determining the perturbing effect exerted on such systems by the less abundant fractions. It has been shown that the hydrocarbon fraction of a lubricating oil is intrinsically unstable toward oxidation and that this oxidation is catalyzed by peroxide. Evidence has been presented, indicating that the natural sulfur compounds present in a finished lubricating oil, by virtue of their ability to reduce petroleum peroxides, are the major factor in rendering an oil resistant to deterioration.

A theory of bearing metal corrosion has been developed involving the reaction of the metal with organic peroxides to yield an oxide which later dissolves by reaction with organic acids. This reaction exhibits a rate proportional to the concentration of peroxide present. Evidence in favor of such a theory is given.

Literature Cited

1. Deanesly, R. M., and Carleton, L. T., *Ind. Eng. Chem.*, Anal. Ed., 14, 220 (1942).
2. Dornte, R. W., *Ind. Eng. Chem.*, 28, 26 (1936).
3. Engler, C., and Kneis, E., *Dingler's Polytechnische Journal*, 263, 193 (1887).
4. Larsen, R. G., Thorpe, R. E., and Armfield, F. A., *Ind. Eng. Chem.*, 34, 183 (1942).
5. Mair, B. J., and Schicktanz, S. T., *J. Research NBS*, 17, 909 (1936).
6. Mair, B. J., Willingham, C. B., and Streiff, A. J., *J. Research NBS*, 21, 585 (1938).
7. Mikeska, L. A., *Ind. Eng. Chem.*, 28, 970 (1936).
8. Vlugter, J. C., Waterman, H. I., and Van Westen, H. A., *J. Inst. Petroleum Tech.*, 21, 661 (1935).
9. Wheeler, D. H., *Oil and Soap*, 9, 89 (1936).

NEW BOOKS FOR THE REFINER

German Articles Discuss Macromolecular Chemistry

"The Chemistry of Synthetic Substances," a collection of five papers by Dr. Emil Dreher previously published in 1941 in German literature, has been published in this country at the suggestion of the National Research Council. The text was translated into English by Marion Lee Taylor.

As the title implies, the articles deal with the chemistry of the macromolecular organic compounds (compounds made up of molecules in which at least thousands of atoms are combined by main valences and in one or several directions). The first of the articles discusses the "Method of Determining Molecular Weight of High Molecular Organic Compounds by Measurement of Viscosity." Following that is a discussion of the development of synthetic paint materials—"Survey of Relation of Synthetic High Molecular Compounds to Drying Oils."

Third and fourth articles in the series are devoted to the principles of the processes of polymerization and polycondensation, respectively. Last of the subjects covered is titled "On the Cognizance of Solubility of High Molecular Film-Forming Substances."

Although a good deal of the material covered is in connection with synthetic paints and similar coatings, the underlying principles brought out are of interest to anyone concerned with the theory and chemistry of synthetics. Considering the highly technical nature of the text, the translation in general seems to be rather well done.

Copies of *"The Chemistry of Synthetic Substances,"* (103 pages, 5½ x 8½ in., stiff cloth binding) can be obtained through the Book Department of NATIONAL PETROLEUM NEWS, 1213 West Third Street, Cleveland 13, for $3.00.

* * *

A. S. T. M. Booklet Describes Water Corrosion Analysis

The use of physico-chemical methods in identifying water-formed deposits, scales and corrosion products is described in a 44-page booklet published by the American Society for Testing Materials. Details and results of experimental tests involving microchemical analyses, petrographic examination and x-ray diffraction are described in the introduction, followed by three technical reports: "X-ray Diffraction Methods in the Study of Power-Plant Deposits," "Diagnosis of Water Problems," and "Interpretation of Analyses and Problems Encountered in Water Deposits."

Copies of the *"Symposium on the Identification of Water-Formed Deposits, Scales and Corrosion Products by Physico-Chemical Methods"* may be obtained from A.S.T.M., 260 S. Broad St., Philadelphia 2, Pa., at 65 cents each.

* * *

'Chemical Formulary' Tells 'How to Make It'

For the refinery chemist interested in blending or compounding many of the common products he has occasion to use, the *"Chemical Formulary,"* a collection of practical formulae and recipes for making many commercial items, will prove a handy "cook book." The sixth volume has just been published, containing several thousand formulae, none of which appeared in the previous five volumes. The material was edited by H. Bennett, F.A.I.C.

Formulae are given for lubricants (wood and fiber, driving journal, Diesel engine, chassis, gyroscope bearing, dental, glass mold, die member, drawing die, metal working, non-gumming, strip steel rolling, pipe-thread, anti-freeze), rust-proofing grease, stop-cock grease, hydraulic fluids, belt dressing, cutting oils, soluble oils, flushing oil, slushing oil, sticky oil, drying oil, harness oil, well drilling fluids, dubbing (leather), petroleum jelly, bleaching oils and fats. Other subjects covered include adhesives, marking compounds, metal treatments, paints and other coatings, plastics and synthetic resins, boiler compounds, welding, etc. A chapter on substitutes for scarce materials may be of use to many.

Copies of *"Chemical Formulary,"* Vol. VI, (636 pages, 5½ x 8½ in., stiff binding) may be obtained through the Book Department, NATIONAL PETROLEUM NEWS, 1213 West Third Street, Cleveland 13, for $6.00.

* * *

A.W.S. Issues 2 New Books On Subject of Welding

Two new publications recently issued by the American Welding Society deal with the subject of welding steel.

First of the two—*"Practical Design of Welded Steel Structures"*—sets forth in concise, usable form the essentials of welding and welded construction. The material contained in this volume of 150 pages provides the designer of plant and equipment with the knowledge of the fabricating tools and methods required for effective work.

Contents of the book include discussions of welding processes, stress distributions and stress paths, temperature effects, design considerations, girders, trusses, columns, beam connections, continuous structures and rigid frames. The growing importance of fatigue in many types of structures is recognized by the inclusion of a section dealing with this topic.

The author is H. Malcolm Priest, engineer with the Railroad Research Bureau, U. S. Steel Corp. Subsidiaries.

Second of the publications is a *"Guide to the Weldability of Steels"*. It presents a proposed system for determining the effect of welding procedure upon the ductility of the heated zone adjacent to the weld in plain carbon and low-alloy steels. The system is sponsored by the War Metallurgy Committee of the National Research Council, based on original investigation work carried on at Lehigh University. The report is published in a paper cover book of 90 pages.

Either publication may be obtained from the American Welding Society, 33 West 39th St., New York, 18; price for each is $1.

Method for Calculating Heat Losses Through Refractory Walls*

A suggested procedure for calculating losses in heat in its transmission through walls of refractory materials is included in the latest manual of Standards on Refractory Materials of the American Society for Testing Materials. In petroleum refineries such a method would find application in the use of refractory walls for boiler furnaces and furnaces for processing units, also in the more recent use of refractory linings for reactor vessels and large size piping in processes where solid catalysts are used, where the refractory material is applied for abrasion resistance to the catalyst at high operating temperatures.

THE HEAT generated in industrial furnaces is transmitted to the charge, the surrounding walls, and the stack. In this discussion there is considered only the heat transfer by conduction through the wall under steady conditions, no attention being given to the effects of infiltration, furnace pressure, open joints, doors, etc.

The heat is transmitted through the refractory walls mainly by conduction and is then transmitted to the surrounding air and neighboring objects by radiation and convection from the outer wall surface. A drop in temperature will occur, and this temperature drop through the wall and from the outer surface to the surroundings will depend upon the resistance offered to the flow of heat.

There is also a drop in temperature from the furnace gases to the interior surface of the furnace walls. Its magnitude depends upon many variables, such as temperature, nature and thickness of flame, whether or not the flame is impinging on the wall, pressure conditions within the furnace, and other factors. Since there are so many variables they will not be discussed in this article. It should be remembered, however, that when a previously uninsulated furnace is insulated, the temperature of the interior surface of the furnace walls will be increased by a small but sometimes consequential amount even though the same "furnace temperature" is maintained.

The quantity of heat transmitted by conduction through the wall per unit area varies directly with the temperature difference between the outer and inner surfaces of the wall, the thermal conductivity of the refractory and insulation, and inversely with the thickness of the same. Conductivities of refractory and insulating materials are usually given as a function of mean or average temperature. Fig. 1 presents, in the form of a graph, conductivity data for three kinds of materials. The values given in these curves are for illustrative purposes only and are not intended to be truly representative of any given materials.

The heat which passes through the walls is dissipated to the surrounding air and objects. The rate of heat transfer depends upon various factors, such as the temperature of the surface and the surroundings, the rate of circulation of air over the wall, nature of surface, etc. Since the total rate of heat transfer through the wall depends upon the resistance of the wall, as well as the resistance to heat flow from the surface of the wall, it is obvious that, before the actual transfer through the wall can be determined, it is necessary to solve for the simultaneous flow of heat through the two media, that is, the wall and surface. The true value of the heat flow is obtained when the solution reached gives the same heat flow through the wall and from its outer surface.

The method suggested in this procedure for calculating heat flow through furnace wall for equilibrium conditions is to assume a temperature for the outer wall surface and to calculate the heat flow through the walls from an assumed mean temperature of the various wall components and their conductivities. The calculated heat flow through the wall is then compared with the heat loss from the outer surface, by radiation and convection, that would occur when the outer surface temperature was the same as assumed. If the two losses are equal and the mean temperatures for the wall components check, the calculations are then complete.

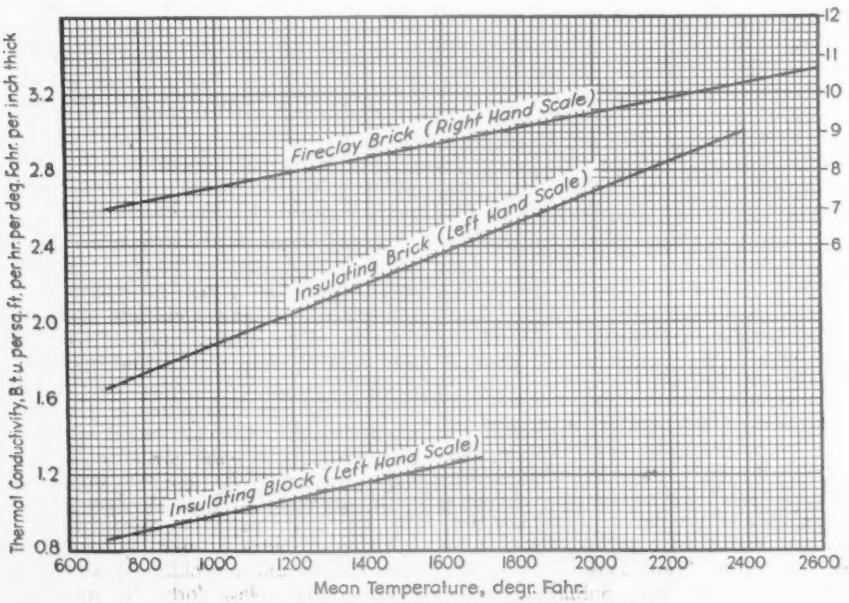


Fig. 1—Assumed values of thermal conductivity

The loss by radiation from the surface to the surrounding air for an assumed surface temperature and the known surrounding temperature can be calculated from the well-known Stefan-Boltzmann formula:

$$q_r = 17.4 \times 10^{-10} \times \epsilon (T_1^4 - T_2^4)$$

where:

q_r = heat loss by radiation, in Btu. per hr. per sq. ft.

ϵ = emissivity of surface, usually about 0.95 for wall surfaces such as brick and cement or rough steel (ϵ is equivalent to approximately 0.28 for fresh aluminum paint),

T_1 = temperature of the outer surface, deg. Fahr. Absolute (deg. Fahr. +460), and

T_2 = temperature of the surroundings, deg. Fahr. Absolute (deg. Fahr. +460),[1]

The heat loss from large surfaces by free or natural convection, or where draughts of air are not blowing over the surface, can be obtained for the same conditions from the formula:

$$q_c = .53C\left(\frac{1}{T_{avg.}}\right)^{.18} dt^{1.27}$$

where:

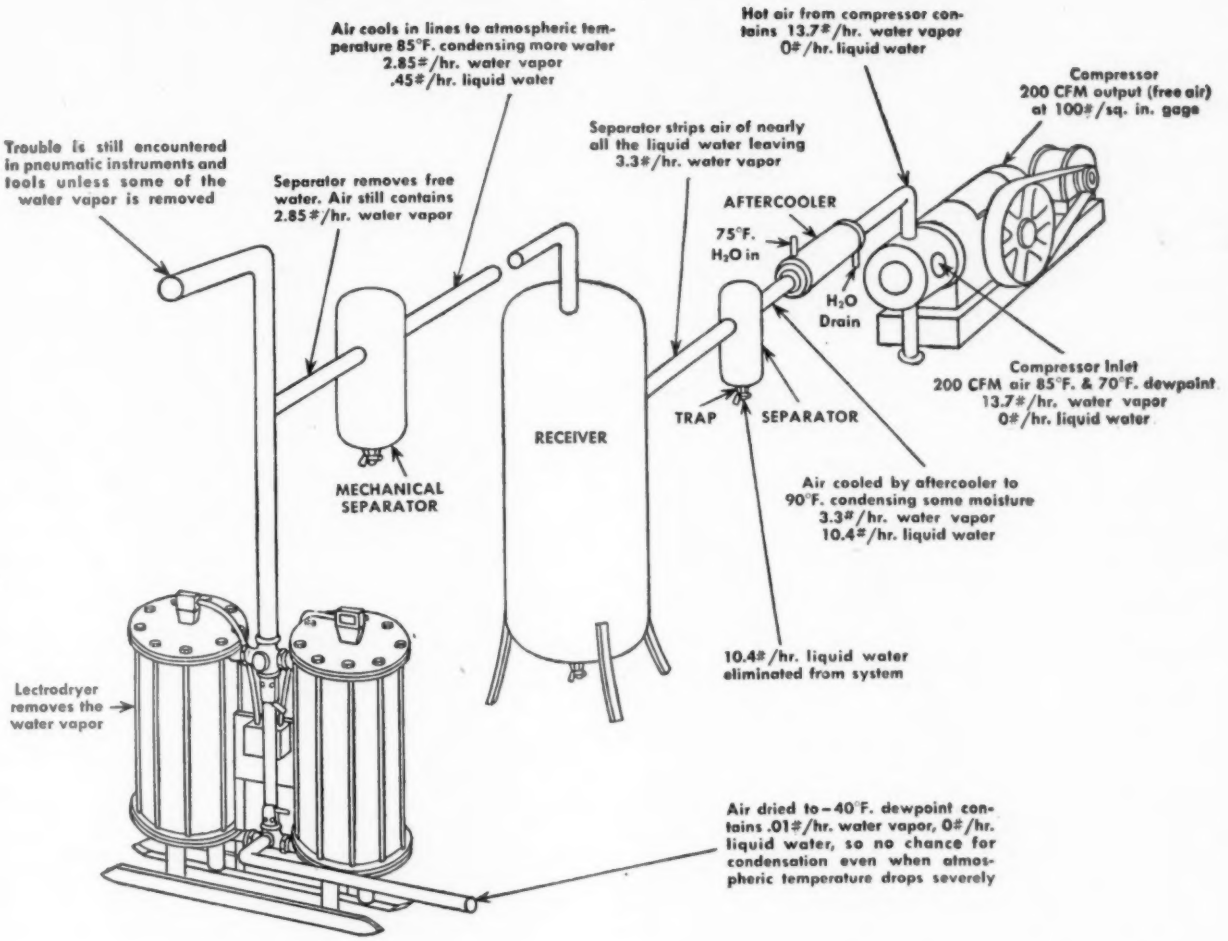
q_c = heat loss by convection, in Btu per hr. per sq. ft.

C = a constant depending upon the shape of the surface. (For a vertical wall, the value is 1.39, for the crown of a furnace the value is 1.79.)

T_{avg} = average of the wall surface and surrounding air temperature, deg. Fahr. Absolute, and

*From the Manual of A.S.T.M. Standards on Refractory Materials of the American Society for Testing Materials. This method is suggested procedure under the jurisdiction of A.S.T.M. Committee C-8 on Refractories and was prepared by the C-8 Subcommittee on Heat Transfer. It is published by the Society for information only and is not an official standard. Copies of the Manual may be secured from the headquarters of the Society, 260 S. Broad St., Philadelphia, at $1.50 per copy, heavy paper cover; $1.75 cloth cover.

[1] Ordinarily the temperature of the surrounding atmosphere is used for T_2.


Air cools in lines to atmospheric temperature 85°F. condensing more water
2.85#/hr. water vapor
.45#/hr. liquid water
Hot air from compressor contains 13.7#/hr. water vapor
0#/hr. liquid water
Compressor
200 CFM output (free air)
at 100#/sq. in. gage
Trouble is still encountered in pneumatic instruments and tools unless some of the water vapor is removed
Separator removes free water. Air still contains 2.85#/hr. water vapor
Separator strips air of nearly all the liquid water leaving 3.3#/hr. water vapor
AFTERCOOLER
75°F. H_2O in
H_2O Drain
Compressor Inlet
200 CFM air 85°F. & 70°F. dewpoint
13.7#/hr. water vapor
0#/hr. liquid water
TRAP
SEPARATOR
RECEIVER
MECHANICAL SEPARATOR
Air cooled by aftercooler to 90°F. condensing some moisture
3.3#/hr. water vapor
10.4#/hr. liquid water
Lectrodryer removes the water vapor
10.4#/hr. liquid water eliminated from system
Air dried to −40°F. dewpoint contains .01#/hr. water vapor, 0#/hr. liquid water, so no chance for condensation even when atmospheric temperature drops severely

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Compression merely crowds the water into a smaller space . . . *Aftercoolers* condense water only to dewpoints determined by temperatures of their cooling water . . . *Separators* remove only the droplets of water too large to be carried over by the air stream . . . *Filters* merely do a somewhat better job than separators, catching more of the water in the liquid phase.

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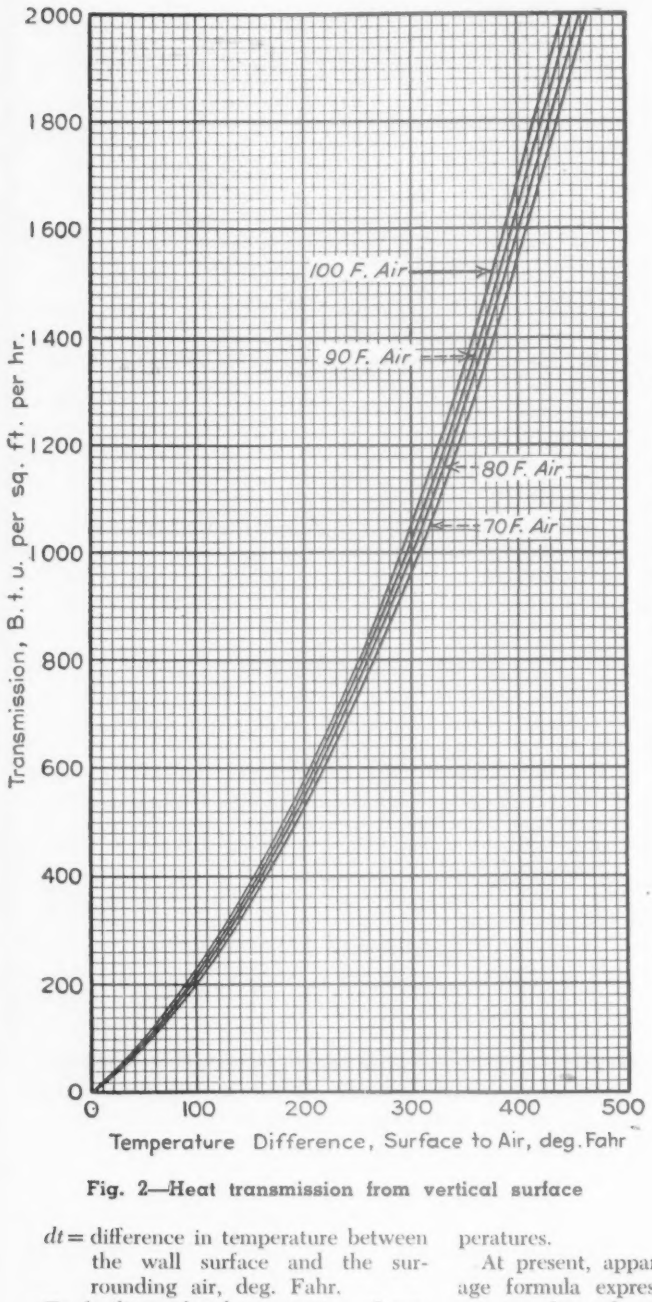


Fig. 2—Heat transmission from vertical surface

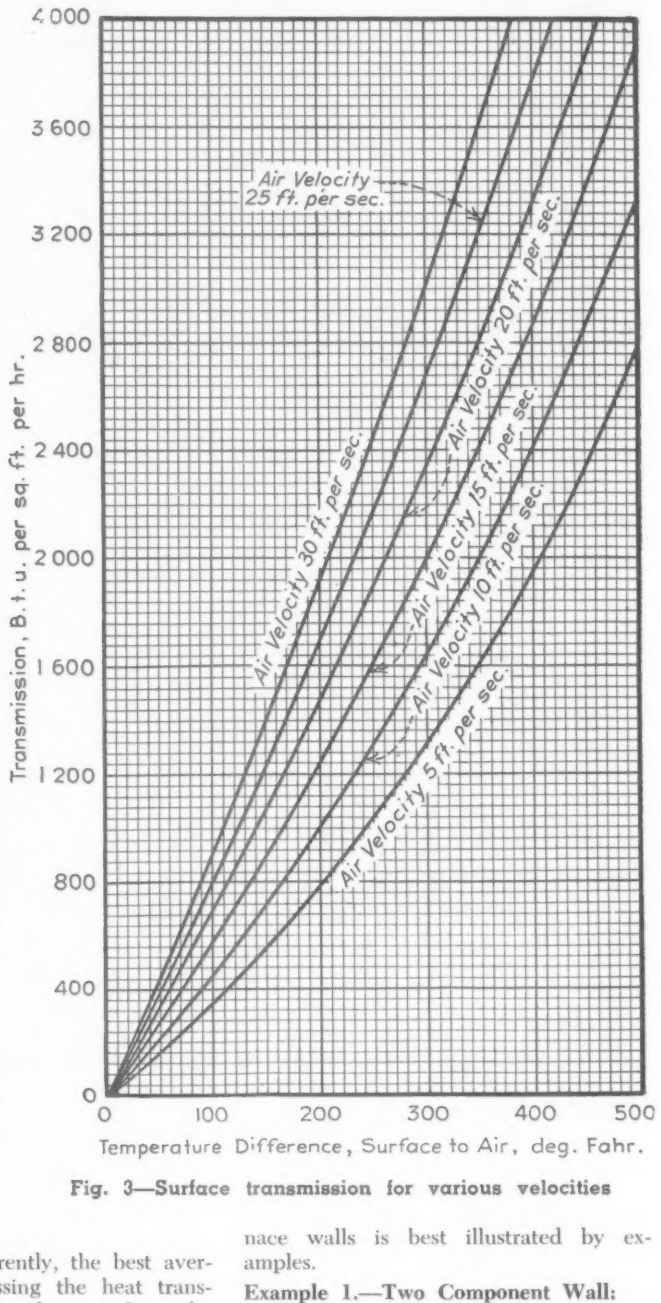


Fig. 3—Surface transmission for various velocities

dt = difference in temperature between the wall surface and the surrounding air, deg. Fahr.

To facilitate the determination of surface heat losses, the radiation and the convection formulas for a vertical wall have been combined for an emissivity of 0.95 and air temperatures of 70 to 100°F. for various temperature differences between the wall surface and the surrounding air. The results of the calculations are shown in Fig. 2.

The furnace may often be located where extraneous drafts of air are blowing over the surface. In such cases, the surface heat transfer coefficient may be increased tremendously if the velocity of the air blowing over the surface is increased to any great extent.

Considerable experimental work has been conducted on the loss of heat by forced convection from wires and cylinders, but there is little available information on forced convection from plane surfaces, especially at high temperatures.

At present, apparently, the best average formula expressing the heat transmission from large plane surfaces by forced convection is:

$$q_{fc} = 1 + .225V$$

where:

q_{fc} = heat transmission in Btu. per hr. per sq. ft. per deg. Fahr., and

V = air velocity in ft. per sec.

The above convection formula has been combined with the Stefan-Boltzmann radiation formula to obtain the curves shown in Fig. 3 for an emissivity value of 0.95 and an air temperature of 70°F. These curves should be used in determining the surface resistance when extraneous air currents are blowing over the furnace. If the air temperature is considerably different from 70°F., new curves can be calculated from the above formula.

The application of the foregoing data in calculating heat losses through furnace walls is best illustrated by examples.

Example 1.—Two Component Wall:

Assume a furnace wall consisting of 13½ in. of fireclay brick and 4½ in. of insulating brick. The interior wall temperature of the furnace is assumed to be 2800°F., and the furnace is located in a building so that the furnace walls are protected from extraneous air currents or from high-temperature radiation. The air temperature is assumed to be 70°F.

The formula for heat flow through walls composed of two or more materials is as follows:

$$Q = \frac{t_1 - t_2}{\frac{L_1}{k_1} + \frac{L_2}{k_2} \cdots + \frac{L_n}{k_n}}$$

where:

Q = quantity of heat conducted in Btu per sq. ft. per hr.,

t_1 = temperature of the hotter surface in deg. Fahr.,
t_2 = temperature of the cooler surface in deg. Fahr.,
$L_1, L_2, \cdots L_n$ = thickness in inches of each course of material, and
$k_1, k_2, \cdots k_n$ = conductivity of each material in Btu per sq. ft. per hr. per deg. Fahr. difference in temperature per inch of thickness

In calculating the heat loss from the above formula, it is necessary first to make an assumption for the outer surface temperature t_2 and the temperature at the junction of each of the wall components from which a preliminary estimate of the mean temperature of each material can be obtained and the thermal conductivity corresponding to the mean temperature of each material substituted in the formula.

The first trial calculation is generally made on rather rough assumptions, as it is not known what the exact temperatures will be. For insulated high-temperature furnaces, the outer surface temperature may be assumed at somewhere between 250 and 350°F., say 350°F.

In making the first assumptions for the temperatures at the junctions of the materials, it is probably quicker to make a rough guess at these temperatures than it is to try to estimate them by proportion from the relative thickness and relative conductivities of the materials. In this example, we will assume a temperature of 2000°F. between fireclay brick and the insulating brick. The corresponding mean temperature of the fireclay brick would be (2800+2000)/2 or 2400°F., and the corresponding mean temperature of the insulating brick would be (2000+350)/2 or 1175°F. The conductivity of the fireclay brick and the insulating brick at these assumed mean temperatures is taken from Fig. 1 and a trial calculation made as follows:

$$Q=\frac{2800-350}{\frac{13.5}{10.25}+\frac{4.5}{2.03}}$$

$$=694 \text{ Btu per sq ft per hr}$$

The temperature drop from the outer surface of the wall to the surrounding air for a heat loss of 694 Btu. is found from Fig. 2 to be 242°F. The surface temperature is, therefore, 242°F.+70°F. (room temperature) or 312°F. Since a surface temperature of 350°F. was first assumed, it will now be desirable to assume a temperature closer to 312°F., or say 320°F., and recalculate on that basis. This is advisable since the error in the original estimate of surface temperature not only affected the estimate of inner face temperature but also influenced the choice of value for thermal conductivity. This recalculation will diminish these errors.

With these recalculations the temperature drop through the wall will now be 2480°F. (that is, 2800°F.−320°F.) and the heat flow for the new assumed surface temperature will be 2480°F. divided by the wall resistance

$$\left(\frac{13.5}{10.25}+\frac{4.5}{2.03}\right)$$

as obtained above or 2480/3.53=702 Btu. Since the temperature drop through each material is equal to the heat flow times the actual resistance of each material, we have:

Temperature Drop Through	Hot Face Temp. deg. Fahr.	Cold Face Temp. deg. Fahr.	Mean Temp. deg. Fahr.
Fireclay brick:			
702 × 1.32 = 928	2800	1872	2336
Insulating brick:			
702 × 2.21 = 1552	1872	320	1096

The conductivities of the fireclay and insulating brick are again taken from Fig. 1 for the above mean temperatures, then the heat flow equation becomes:

$$Q=\frac{2800-320}{\frac{13.5}{10.15}+\frac{4.5}{1.96}}$$

$$=685 \text{ Btu per sq ft per hr}$$

From Fig. 2, it is seen that for a heat loss of 685 Btu. the temperature drop is 240°F., or the surface temperature is 310°F. This is close enough for all practical purposes to the surface temperature of 320°F. assumed above, so the heat loss 685 Btu.

Example 2.—Three Component Wall:

Assume a furnace wall consisting of 13½ in. of fireclay brick, 4½ in. of insulating brick, and 2 in. of insulating block. The interior wall temperature of the furnace is assumed to be 2800°F., and the outer surface, which is encased in a steel shell, is exposed to an air current of 15 ft. per sec. or slightly over 10 mph. The air temperature is assumed to be 70°F.

In this case the draft of air will lower the outer surface temperature and increase the heat loss. For the first trial calculation, assume an outer surface temperature of 180°F., a temperature of 2200°F. on the cooler face of the fireclay brick, and a temperature of 1500°F. on the cooler face of the insulating brick. The mean temperatures of the various materials for the above assumptions are as follows:

Fireclay brick

$$\frac{2800+2200}{2}=2500°\text{F.}$$

Insulating brick

$$\frac{2200+1500}{2}=1850°\text{F.}$$

Insulating block

$$\frac{1500+180}{2}=840°\text{F.}$$

The conductivities corresponding to these mean temperatures are obtained from Fig. 1 and the first trial calculation made as follows:

$$Q=\frac{2800-180}{\frac{13.5}{10.45}+\frac{4.5}{2.56}+\frac{2}{.92}}$$

$$=501 \text{ Btu per sq ft per hr}$$

The temperature drop from the outer surface to the surrounding air for a heat loss of 501 Btu. is found from Fig. 3 to be 88°F. The surface temperature is, therefore, 88°F.+70°F. (air temperature) or 158°F.

A surface temperature of 158°F. will now be assumed and a recalculation made on that basis. The temperature drop through the wall will now be 2642°F. and the heat flow for the new assumed surface temperature will be 2642°F. divided by the total wall resistance as obtained above or 2642/5.23= 505 Btu. Since the temperature drop through each material is equal to the heat flow times the actual resistance of each material we have:

Temperature Drop Through	Hot Face Temp. deg. Fahr.	Cold Face Temp. deg. Fahr.	Mean Temp. deg. Fahr.
Fireclay brick:			
505 × 1.29 = 652	2800	2148	2474
Insulating brick:			
505 × 1.76 = 889	2148	1259	1704
Insulating block:			
505 × 2.18 = 1101	1259	158	708

The conductivities of the refractory and insulating materials are again taken from Fig. 1 for the above mean temperatures, then:

$$Q=\frac{2800-158}{\frac{13.5}{10.4}+\frac{4.5}{2.45}+\frac{2}{.86}}$$

$$=483 \text{ Btu per sq ft per hr}$$

From Fig. 3, it is seen that, for a heat loss of 483 Btu., the temperature drop is 85°F., or the surface temperature is 155°F. The heat flow for an assumed surface temperature of 155°F. and a total wall resistance of 5.47= 2645/5.47= 484 Btu. per sq. ft. per hr. The temperature gradients and mean temperatures for the above heat flow and individual resistances are as follows:

Temperature Drop Through	Hot Face Temp. deg. Fahr.	Cold Face Temp. deg. Fahr.	Mean Temp. deg. Fahr.
Fireclay brick:			
484 × 1.3 = 628	2800	2172	2486
Insulating brick:			
484 × 1.84 = 890	2172	1282	1727
Insulating block:			
484 × 2.33 = 1127	1282	155	719

The mean temperatures indicated above check very well with the mean temperatures upon which the above calculations were made, also the outer surface temperature will not change for a change in heat flow from 483 Btu. to 484 Btu. The heat loss through the furnace wall is, therefore, 484 Btu. per sq. ft. per hr.

Hydraulic Speed Control of Diesel Engines in Pipeline Pumping Service*

*By J. Ray Polston***

The hydraulic speed control is used on engines that drive pumps on cross-country pipelines to eliminate evaporation losses of the oil handled. By synchronizing the pumping rate of two or more stations spaced from 40 to 100 miles apart it is possible to reduce movement of oil in and out of working tanks at the relay pump stations. Evaporation losses are reduced by maintaining a constant oil level in the tanks.

The hydraulic speed control, a device attached to the engine governor, controls engine speed by positioning the governor speeder spring by means of hydraulic pressure from the pump suction line. An increase in pressure causes the engine to speed up with a corresponding increase in the pumping rate. When the suction pressure drops, the pumping rate decreases. By operating all engines except one at nearly constant speed, and varying the speed of the one engine by pump suction pressure at a relay pump station, the pumping rate is controlled by, and is equal to, the pumping rate at the station from which it receives oil.

DIESEL engines as prime movers of pipeline pumping equipment have been in use for the past 30 years. Governors on the earlier type engines were crude and in most instances merely an adaptation of the old steam engine flyball type. Later designs made use of spring loaded weights, the speed variation being accomplished by varying the tension on a spring. More recent designs have made use of some of the principles of the older type governors, incorporated with a hydraulic cylinder into which an oil pressure is maintained against a piston actuating the fuel control system of the engine.

Speed regulation with the former types was not particularly accurate; however, with engine speeds of that time ranging from 150 to 200 R.P.M., accurate speed regulation of pipeline pumping engines was not an essentiality.

With the advent of higher speed engines, better governors and better control methods became imperative. These higher speed engines were found to be suitable for driving a different type of pumping equipment; namely, the centrifugal. Through a set of step up gears, speeds of 257 R.P.M. and above were readily increased to 1750 and 3600 R.P.M. These speed ranges made possible a cheaper and more flexible pipeline pumping unit than previously with the old low speed engines and reciprocating pumps. This development brought forth additional possibilities of increasing speeds of existing engine and pump installations, and supercharging of engines. With greater pump speeds and larger plunger sizes to utilize the additional horsepower developed, the need for filling the pumps under pressure became apparent.

How Losses Were Reduced

Another problem of long standing confronting the pipeline engineer was enormous evaporation losses resulting from the old practice of floating a large tank on the suction to the pumps at each station. The oil received from the preceding station was either received directly into a tank where it was measured and later pumped out, or it was received into the suction line to the pumps, between pumps and tanks. Either method resulted in large evaporation losses. Extensive tests at one station handling over 100,000 bbls. of crude oil daily showed an evaporation loss amounting to over $40 per day. The need for a closed pumping system became apparent and the back pressure control valve was designed. The installation of this device is shown in Fig. I This consists of a diaphragm operated, balanced-inner-valve, relief type, spring loaded regulator installed in the tank suction line between the tank and incoming receiving line connection. A swing check valve is installed on a by-pass connection around regulator valve to permit pumps taking suction directly from the tank when pumping more oil than is received.

By carrying 10 to 15 pounds pressure on the suction of the pumps, two purposes were accomplished. First, the pumps which had been increased in speed and capacity were adequately filled, thus increasing their volumetric efficiency. Second, the oil for great distances could be kept moving through the pipeline without going in and out of tanks at each station; consequently, excessive evaporation losses are avoided.

The development of the back pressure control valve and its use made possible a means of controlling the speed of pumping engines hydraulically for synchronizing the speed and pumping rate of one station with another. This was accomplished over a period of about one year during which several different types of devices were designed and tested.

The hydraulic speed control governs the speed of the engine by positioning the governor control spring by means of pressure from the suction of the pump. Its purpose is to automatically control the pumping rate of an entire pump station or group of stations from the pressure on the incoming lines so that a minimum of liquid will pass in and out of the working tanks to reduce evaporation losses. This control is so sensitive that the pumping rate of an

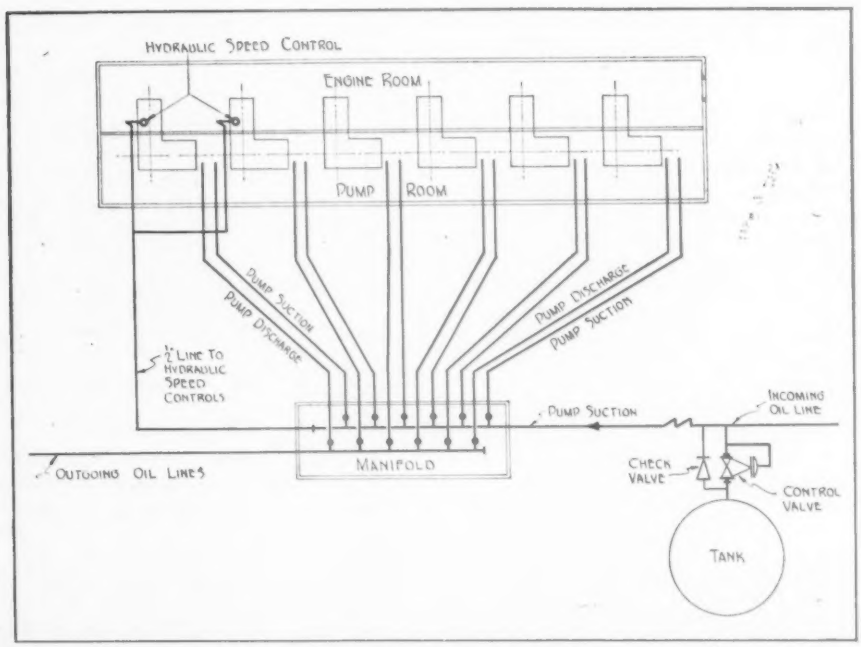
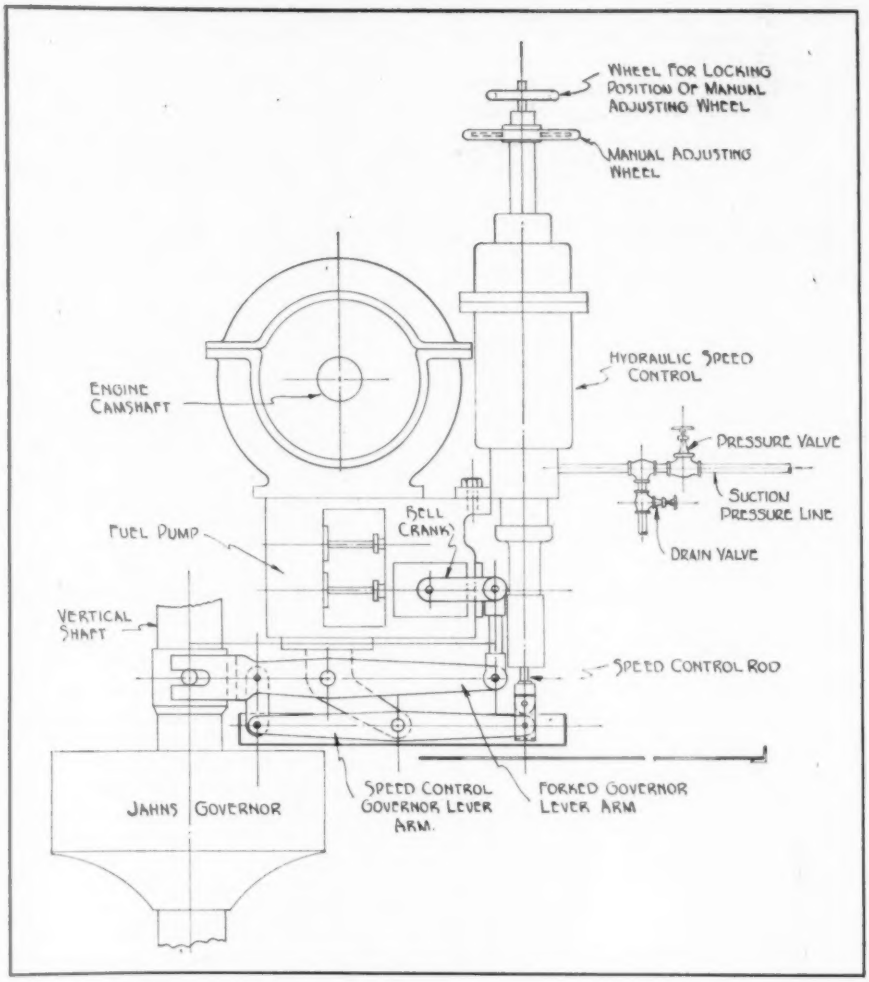


Fig. 1—Diagrammatic layout showing hydraulic control on two units of 6-unit pump station

*Contributed by the Oil and Gas Power Division for presentation at the national meeting, Tulsa, May 8-10, 1944, of the American Society of Mechanical Engineers.

**Engineer, Stanolind Pipe Line Co., Tulsa.



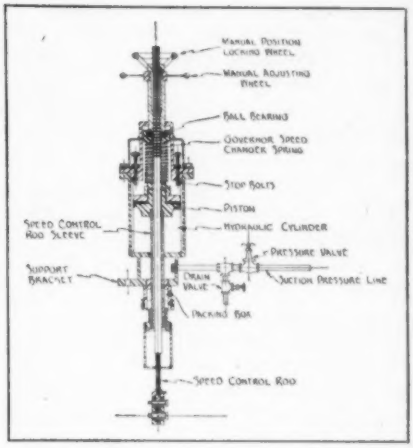


Fig. 3 (above)—Outline elevation of direct piston operated control

Fig. 2 (left)—Sectional elevation of direct piston operated control

entire 6-unit pump station may be controlled by varying the speed of only one of the larger pumping units. It is advisable, however, to install hydraulic control on two engines in order to provide flexibility of operation and for shutting down to make adjustment and repairs.

Any acceptable design must permit the engine governor to operate against the speeder spring originally furnished by the manufacturer and include means for disengaging the hydraulic device for manual control. It must also provide limit stops for the traveling part of the hydraulic device to prevent the danger of excess engine speed. Excess pressures do not affect the operation. The stops are set for the minimum engine speed at zero pressure and for maximum speed at the pre-determined maximum pressure. Pressure in excess of the pre-determined maximum will not further increase the engine speed.

Figs. 2 and 3 are outline and sectional elevations of a direct piston operated hydraulic control for Jahns governor on a 250-horsepower engine.

Direct Piston Operated Control

The governor speeder spring is installed so it will oppose the hydraulically operated piston. An increase of pump suction pressure causes the piston to compress the spring which in turn exerts pressure on the speed control rod. A drop in pressure reverses this procedure. Upward movement of the speed control rod causes an increase, and downward movement a decrease of the engine speed.

For hydraulic operation, the pressure valve is open and drain valve is closed.

Manual operation is accomplished by shutting off the hydraulic pressure and operating the manual adjusting wheel. The piston rests on bottom end of hydraulic cylinder and the adjusting wheel compresses governor speed changing spring to the desired engine speed. The small wheel above the manual adjusting wheel is used for locking the latter in any desired position.

Piston Operated Speed Screw Control

Fig. 4 shows a piston operated speed screw control for Woodward governor on a 1000-horsepower engine.

Pump suction pressure forces piston upward and the gear rack turns the small inside engaging gear and the large outside gear. The larger gear engages and rotates the small gear on the speeder screw extension shaft. Rotation of the extension shaft and speeder screw shaft are simultaneous as indicated in Fig. 4. The engine speed varies with the circular position of the speeder screw shaft. The stationary position of piston is fixed by the spring for any given pressure in the hydraulic cylinder. A corresponding circular position of the speeder screw shaft is taken for any fixed position of the piston. The total piston travel represents total rotary movement of the governor speeder screw shaft.

To disengage the hydraulic device the operator pushes in on the knob on outer end of speeder screw extension shaft. A spring actuated steel ball holds shaft in either "in" or "out" position as indicated in plan view of Fig. 4. When the hydraulic device is cut out the engine governor is operated manually.

Direct Bellows Operated Control

Fig. 5 shows a direct bellows operated control for Woodward governor on a 250-horsepower engine.

The sylphon bellows are installed inside the hydraulic cylinder. Pump suction pressure on the closed upper end forces it down until the effective hydraulic force equals the combined opposing forces of the bellows, the bellows spring, and the governor speeder spring. The bellows push rod is attached to the upper inside end of bellows. The speeder spring push rod moves up and down through push rod guide bushing with upper end of speeder spring. Downward movement of upper end of bellows thus causes a corresponding movement of upper end of speeder spring and thereby compresses it permitting more fuel oil to be pumped to engine cylinders.

A decrease of hydraulic pressure in the hydraulic cylinder permits bellows spring to force top end of bellows upward. The governor speeder spring expands a like amount, moving speeder spring push rod upward. The expansion

of speeder spring permits governor to reset and reduce the engine speed. At constant hydraulic pressure, the engine speed is constant.

The pressure operating range may be altered by changing position of threaded adjustment nut.

The locknut on speeder spring push rod acts as travel stop for the control. The push rod cap is also locked in position with a cotter pin as a safety precaution.

For manual control the pressure valve is closed and drain valve open. The knob on speeder screw shaft, shown in Fig. 5 is rotated by hand. The speeder screw shaft is connected through a gear train to the rack on one side of speeder spring cap. Downward movement of the cap compresses speeder spring for increasing the engine speed in same manner as described above for hydraulic operation.

Bellows Operated Pilot Control

Fig. 6 shows a bellows operated pilot control for Woodward governor on a 730-horsepower engine.

The bellows and pilot valve control assembly are fitted together in a special housing that replaces the governor cover plate.

The adjusting screw between speeder spring and the floating differential piston is used to adjust the governor between minimum and maximum speeds. The pilot valve plunger controls vertical movement of differential piston by directing the governor accumulator pressure to and from its upper large diameter. Downward movement of differential piston compresses governor speeder spring causing the governor adjustment to be increased with subsequent increase of engine speed.

Governor accumulator pressure is maintained around the lower small diameter of the differential piston. Movement of pilot valve plunger uncovers port in differential piston to admit or release pressure to or from upper large diameter. Downward movement admits pressure and upward movement releases pressure. Pressure differential causes identical vertical movement of pilot valve plunger and differential piston.

When pump suction pressure, in annulus surrounding the sylphon bellows, compresses bellows, the pilot valve plunger is forced downward by the pressure transmitted through push rod and push rod lever. This admits governor accumulator pressure to large diameter of differential piston. A reduction in pump suction pressure permits bellows spring pressure to expand the bellows, and pilot valve spring lifts pilot valve plunger, releasing pressure from large diameter of differential piston.

The speed control may be made inactive by increasing the engine speed by manual adjustment, to a value above that being maintained by the speed control while maintaining the desired pump suction pressure. To cut the speed control out of service for complete manual operation, the pump suction pressure is shut off and drain valve opened.

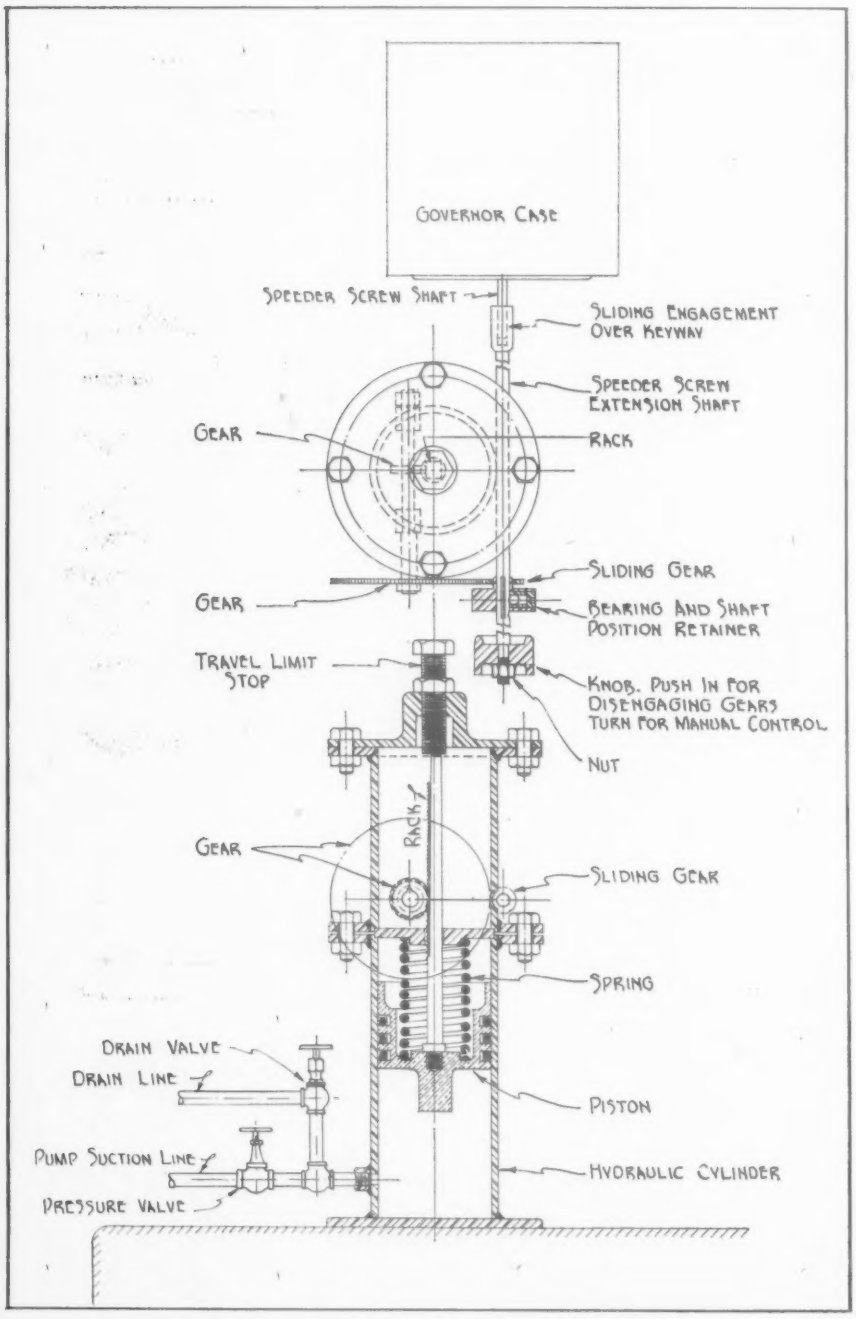


Fig. 4—Piston operated speed screw control

Results and Conclusions

The following results have been obtained from combined use of hydraulic speed control and back pressure regulator valve:

(1) Reduced evaporation losses.
(2) Improved filling of pumps, thus permitting an increase of pump speed for providing additional capacity of present equipment.
(3) Permitted increase in velocity of oil in pump suction lines.
(4) Greater sensitivity of operation, i.e., leaks are more readily detected in lines with controlled suction pressures.

In some instances, at stations pumping to terminals, recording tachometers have been installed in conjunction with the hydraulic speed control that record engine speed variations. It also provides a record of engine operation and has proved valuable in determining the cause of pressure drop in discharge lines or any variation in deliveries at terminals.

Although no definite figures are available that show the savings resulting from the use of hydraulic speed control on pipeline pumping engines, it is believed, after 6 years of development and testing this principle at certain stations, that an appreciable reduction in evaporation

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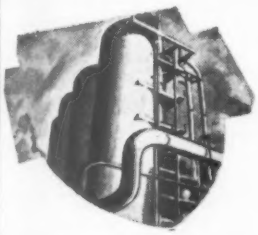
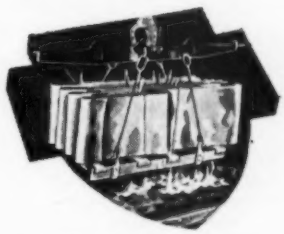


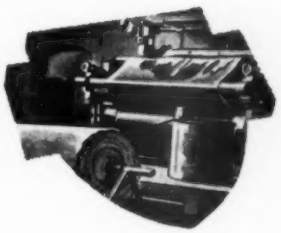
Petroleum
Alkylation, sulfonation, and improving color, odor, and stability of petroleum products.

Rayon
Used in the spinning bath in rayon manufacture.

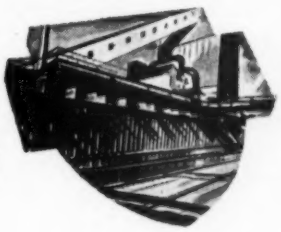


Steel
For pickling of steel sheets and castings; removes oxides and scales.

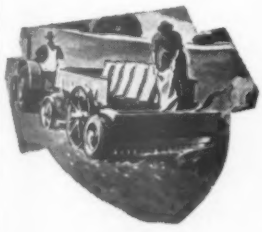
Paints
Raw material in production of pigments; for sulfonating drying oils.



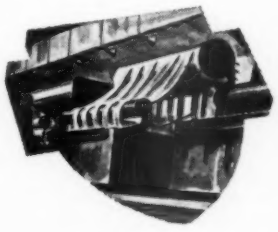
Sulfonation
Sulfonating vegetable oils for water, fire, and mildew-proofing fabrics and textiles.



Coke By-Products
For washing toluene and benzene, raw materials for dyestuffs and explosives.



Fertilizers
Used in super phosphate and ammonium sulfate production.



Textiles
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losses has been effected. Our company has not made full use of the possibilities of hydraulic speed control; however, it is expected that the principle may eventually be used extensively, and it is our opinion that complete closed pumping systems for great distances are possible.

The author offers his apologies for having digressed in some instances from the main subject of Diesel engines. However, it should be understood that the operating, maintenance, and control methods of Diesel engines in pipeline service are so interrelated to many other pipeline engineering problems that it is difficult to thoroughly cover one subject without including some of the more closely related problems.

Acknowledgement

W. G. Heltzel and J. B. Harshman collaborated with the writer in development of this equipment. The writer also wishes to thank Mr. Harshman for helpful assistance in preparation of this paper.

C. C. Keane and F. E. Richardson built the first direct bellows type control for the Great Lakes Pipe Line Co.

The Woodward Governor Co. manufactured the first bellows operated pilot control for the Stanolind Pipe Line Co.

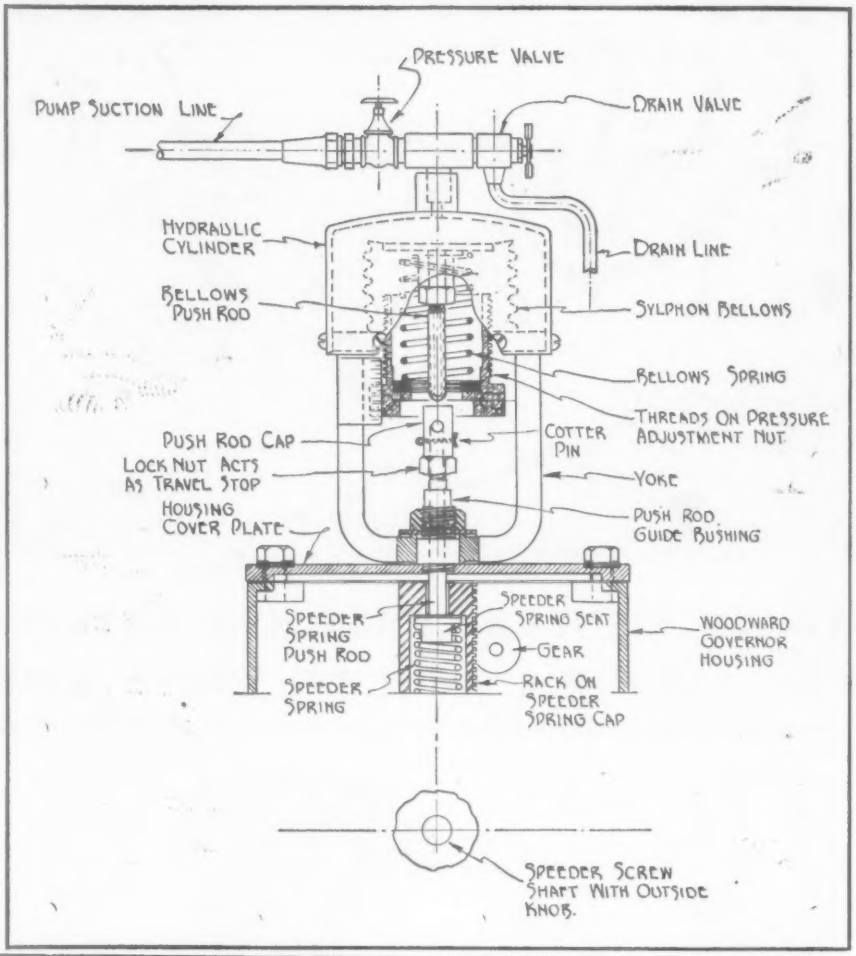
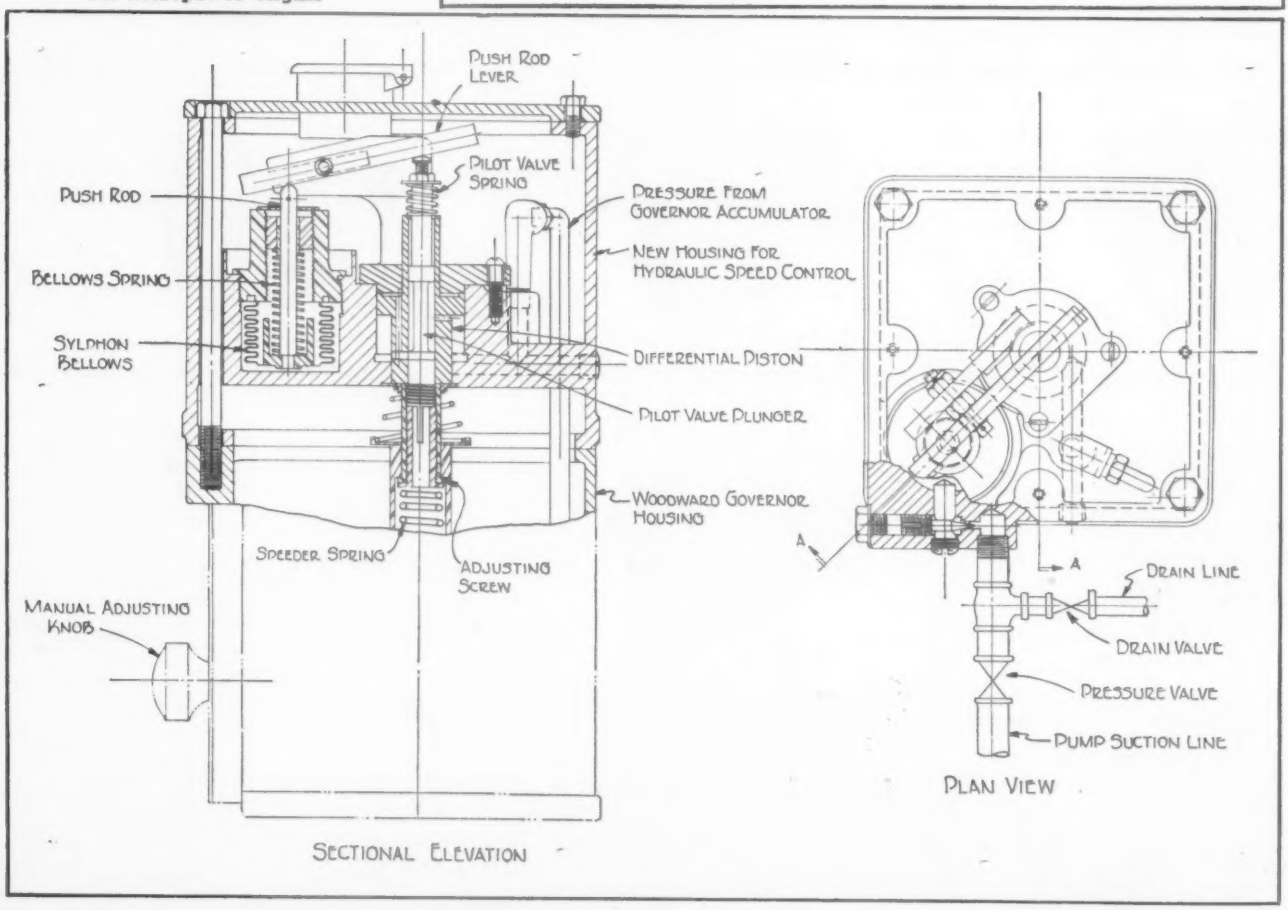
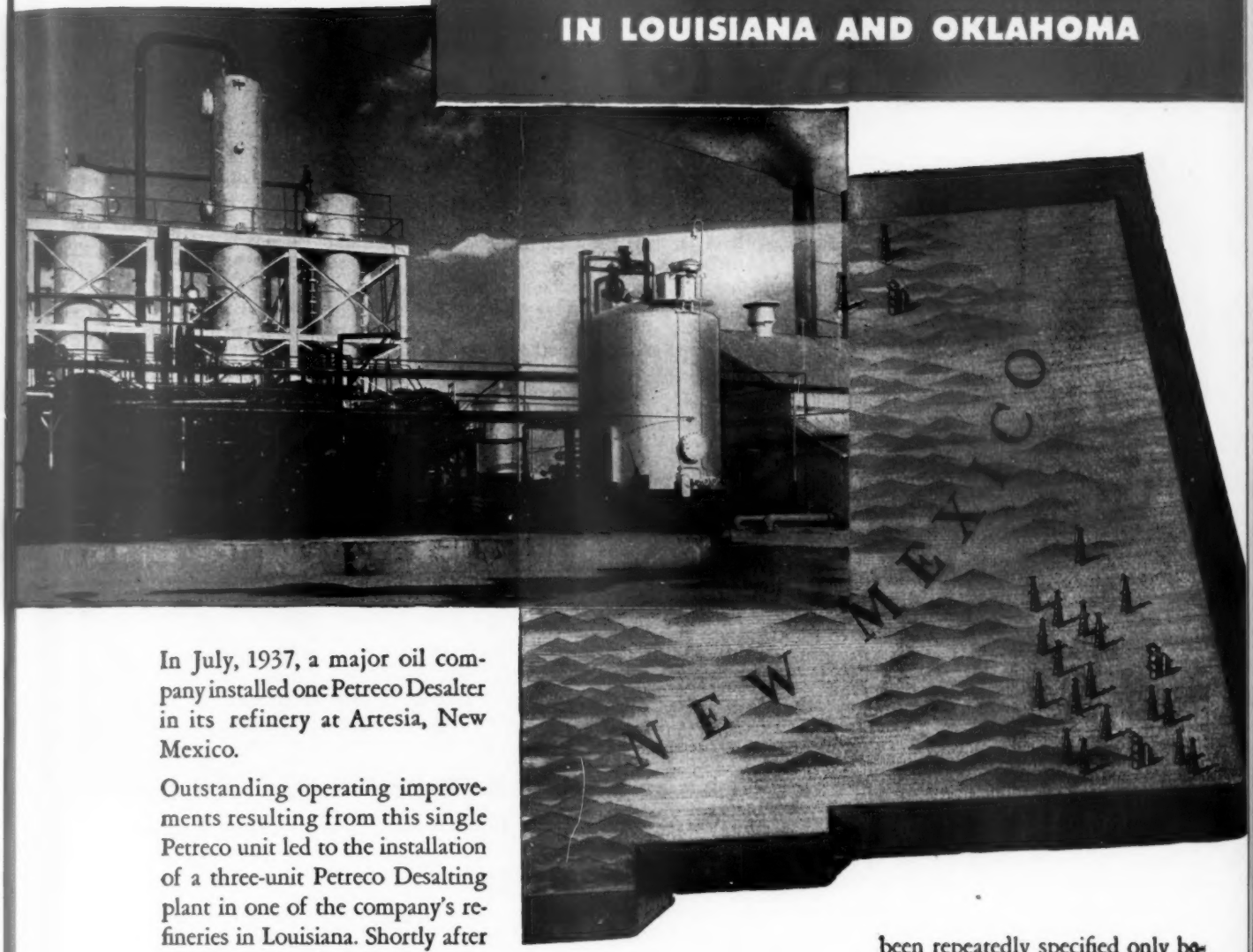


Fig. 5 (right)—Direct bellows operated control for Woodward governor on a 250-horsepower engine

Fig. 6 (below)—Bellows operated pilot control for Woodward governor on a 730-horsepower engine



How a Petreco Desalter in New Mexico Benefited Operations in Louisiana and Oklahoma



In July, 1937, a major oil company installed one Petreco Desalter in its refinery at Artesia, New Mexico.

Outstanding operating improvements resulting from this single Petreco unit led to the installation of a three-unit Petreco Desalting plant in one of the company's refineries in Louisiana. Shortly after the three-unit plant began operation, an eight-unit Petreco installation was specified for a second Louisiana refinery...and following this, Petreco was asked to design and install a special high-capacity desalter for an Oklahoma refinery.

Recognizing the efficiency of this major oil company's many operations, Petreco naturally is proud of these installations, since it is obvious that Petreco Desalting has been repeatedly specified only because it yields maximum results.

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DESALTING DEHYDRATIN

Key Technologists in New Wartime Plants

James Harrop

Humble Oil & Refining Co. Baytown Plant

PRESENT large scale production of 100-octane aviation gasoline by Humble Oil & Refining Co. at Baytown, Texas, is the result of groundwork laid several years before our nation's entry into war. As early as 1937, a unique 200-mile pipeline was built to bring natural gasoline and butane from the East Texas field to Baytown for processing at a thermal polymerization unit, built at the same time.

Today, these are vital war facilities; the combination of the two began to play an important part in Humble's production of high-octane gasoline many months prior to Pearl Harbor. In 1938, Humble placed in operation the world's first commercial alkylation plant. Superfraction and butane isomerization units followed closely, and since our entry into the war two large Humble-owned fluid catalytic cracking units have been added to accelerate the program and place Baytown refinery in the position of having produced more 100-octane gasoline and components for war than any plant in the nation to date.

This program has of necessity called for the skill and ingenuity of many qualified men. Pictured in this issue, with brief outlines of their technical training and industrial experience, are the men actually directing the 100-octane gasoline production program for Humble at Baytown.

James Harrop, general superintendent of Baytown plants, received his bachelor's and master's degrees in chemical engineering at Massachusetts Institute of Technology. He was retained at M.I.T. as an instructor in industrial chemical engineering and plant design until September, 1922, when he came to Baytown as first chemical engineer in the engineering department.

He later served as an assistant to the superintendent and second assistant superintendent before going to the Houston office as assistant to the manager of refineries. When the Houston engineering department was organized, he became assistant chief engineer.

Returning to Baytown, he became assistant refinery engineer, and later head of the technical service division. From the directorship of the technical service division, Mr. Harrop moved up to assistant superintendent in charge of coordination, pumping and gauging, and docks. For the past few years he served as assistant general superintendent of Baytown refinery.

* * *

Karl Opryshek, now in charge of process units at Baytown refinery, started with Humble in 1922 in the pipe department at Baytown. Two weeks later he went into the treating department, where he worked until he transferred to the process operating units in 1925. Prior to 1943 he was for several years assistant foreman of the process department.

A native of Austria, Mr. Opryshek's family emigrated to this country when he was a boy. He attended Texas A. & M. College four years.

Karl Opryshek

J. S. Palmer

Ernie W. Hunt

* * *

J. S. Palmer, foreman of the cracking coil department, attended Port Arthur Junior College. He started with Humble in the laboratory at Baytown in November, 1920. In the early part of 1921, the old Burton high pressure stills were put into operation and he was among the initial operators. In 1923 he was made assistant foreman of the cracking coil department. Since 1940 he has been foreman of the department.

* * *

Ernie W. Hunt, assistant foreman of the cracking coil department, launched his career with Humble at Baytown in January, 1921. His first service was in the pipe department of the mechanical division. In May of that year he transferred to the process department, working at various crude still batteries until February, 1929, when he was sent to Humble's refinery at McCamey as foreman of the

Frank C. Fowler

J. N. Chatfield

M. H. Saxon

H. H. Meier

W. B. Franklin

A. A. Draeger

cracking coils, and later assistant plant superintendent.

When operation of the McCamey plant was discontinued, he returned to Baytown as shift foreman of the cracking coil department. In 1937 he became assistant foreman of that department, when the polymerization unit was put into operation.

° ° °

Frank C. Fowler started with Humble in March, 1926 at the Baytown refinery laboratory. Four months later he took up duties in the gas plant department as a pumper.

From pumper he moved steadily upward, and soon became assistant foreman. A short time later he was made general foreman. When the light ends fractionating units were built and put into operation in 1940, the gas plant department became known as the light ends department. Mr. Fowler's duties and responsibilities were similarly enlarged and he is now general foreman of that department. Prior to employment with Humble, Mr. Fowler worked at the Magnolia refinery wax plant in Beaumont.

° °

J. N. Chatfield, assistant general foreman of the light ends department, is a graduate of the University of Alabama, where he received his bachelor of science degree. He took post graduate work at Louisiana State University, majoring in chemical engineering.

Mr. Chatfield started with Humble in the Houston office, February, 1934, as a member of the geophysical department. In 1936 he transferred to the technical service division at Baytown refinery. From February, 1937 to January, 1939, he was a process engineer, and took up his present duties in the gas plant department (later the light ends department) in February, 1939.

° ° °

M. H. Saxon, light ends department foreman, launched his service with Humble at Baytown Refinery pipe department in August, 1923. Working later in the pumping and gauging department, he transferred to the gas plant department in June, 1928. Except for a short time at the Baytown Ordnance Works, July 1941 - January, 1942, Mr. Saxon has remained in the light ends department as departmental foreman.

D. A. Smith

George Horton

C. F. Jones

H. H. Meier, assistant manager of technical and research work, attended the University of Texas six years, receiving his bachelor and master of science degrees. He began his career with Humble at the Baytown refinery laboratory in February, 1927. When the new projects group was organized, he was assigned to it in August, 1938. This section deals with special units to be constructed, some of which are now playing a vital role in the production of aviation gasoline and other petroleum war products.

He majored in chemical engineering while at Texas University, and also was an instructor in chemistry. Before joining the Humble organization, he was assayer for a graphite mine for a short time.

° ° °

W. B. Franklin, assistant division head of the technical service division, attended the University of Texas eight years, receiving his bachelor and master of science degrees in chemical engineering, and his doctor's degree in physical chemistry. He was part-time instructor at the university, teaching chemistry, and chemical engineering. He went to work with Humble in the technical service division, in June, 1934, as a chemical engineer in distillation and gas plant operations. He later served as a section head before assuming his present duties.

° ° °

A. A. Draeger, senior project engineer, also attended the University of Texas eight years, receiving his bachelor and master of science degrees in chemical engineering, and his doctor's degree in physical chemistry. For four years he was an instructor at the University, teaching chemistry, analytical chemistry and chemical engineering. He joined Humble's technical service division at Baytown refinery in June, 1935. When the new projects group was organized he was made a member of that section in 1938.

° ° °

D. A. Smith, technical service section head, light ends department attended the University of Nebraska five years, receiving his bachelor of science degree. He then attended the University of Michigan a year and completed his master of science degree work before joining the

George Shipley

Otto Gerbes

Bryson M. Filbert

R. E. Tannich

H. G. Corniel

George Atkins

Humble Co. in September, 1936. He is now on leave in a special capacity with the PAW in Washington.

° ° °

George Horton, head of distillation, and light ends section of the technical service division, received his bachelor of science degree in chemical engineering at Yale, and finished his master's degree in chemical engineering at Massachusetts Institute of Technology.

He joined Humble in March, 1937, as a member of the technical service staff. In August, 1938, he was attached to the gas plants department in a technical capacity and two years later transferred to the company's Ingleside refinery near Corpus Christi, as head of the technical service division, in which capacity he served until April, 1943, when he returned to Baytown.

° ° °

C. F. Jones received his bachelor of science and master's degree in chemical engineering and Ph. D. degree in physical chemistry at the University of Texas. He became associated with the Humble organization in June, 1937, as a member of the technical service division. After a short time in the laboratory division, he returned to the technical service division, where he is now section head of the cracking section.

° ° °

George Shipley, senior chemical engineer, attended Rice Institute five years, receiving his bachelor of science degree and completing a year's post graduate work before obtaining his master of science degree at M.I.T.

Prior to joining Humble, he carried on laboratory work for the United Gas Co. in Texas and Louisiana. He started with Humble in the labor department, June, 1936. He later worked in the pipe department and the distillation department before joining the technical service staff December, 1937. In September, 1941, he was transferred to the technical service staff of the Baytown Ordnance Works, a toluol plant operated by Humble, but returned to the refinery technical service division June, 1942.

° ° °

Otto Gerbes, senior chemical engineer, received his bachelor and master's degree in chemical engineering from the University of Texas. Before joining Humble he operated his own refinery in San Antonio for five years. A combination cracking unit, the plant produced gasoline, tractor fuel, and fuel oil. He came to Humble's technical service staff in September, 1939. In 1942, he was sent to Africa on a special mission in connection with aviation gasoline supplies. Mr. Gerbes is at present a member of the isomerization sub-committee of the PAW.

° ° °

Bryson M. Filbert, laboratory section head, attended Penn State, receiving his bachelor of science degree in chemical engineering. He joined Humble's laboratory division June, 1936, and is at present head of research Section C, which conducts pilot unit tests.

° ° °

R. E. Tannich, laboratory section head, attended the University of Texas six years, obtaining his bachelor and master's degrees in chemical engineering. He joined Humble's laboratory division staff in June, 1927. In May, 1932, he transferred to the technical service staff, and a month later went to the Ingleside refinery technical service division. He returned to Baytown laboratory division in August of 1934.

° ° °

H. G. Corniel, assistant section head of the research group of the laboratory division, completed work for his bachelor of science degree in chemical engineering at Oklahoma University. He started with Humble in the labor department in June, 1936. A year later, after a short time in the pipe department, he transferred to the laboratory division.

Previously he worked in drilling, producing, and refining departments of oil companies in the Texas Panhandle. He served 14 months on the isomerization sub-committee of the aviation gasoline advisory committee of the PAW. Recently he returned from a special trip by plane for the Allied government to Near East war theatres.

° ° °

George Atkins, senior engineer in the process engineers design subdivision attended Washington University in St. Louis four years, receiving his bachelor of science degree in chemical engineering. Before aligning himself with Humble, he was a member of the Bureau of Chemicals and Soils, U. S. Department of Agriculture, in Austin for a year. He started with Humble's technical service division in November, 1939.

° ° °

George Robinson, mechanical engineer in the mechanical engineering design subdivision, completed his bachelor of science degree in electrical engineering at the University of Illinois. He also completed special courses at Union College in Schenectady, N. Y., and a year of advanced engineering study with the General Electric Co. He started with Humble's engineering department in September, 1936.

° ° °

J. W. Young, mechanical engineer, mechanical engineering design subdivision, attended Texas A. & M. College where he received his bachelor of science degree in engineering. He started with Humble in the inspection department in June, 1936. In July, 1939, he transferred to the project engineers.

° ° °

H. J. Mason, mechanical engineer in mechanical engineering design subdivision, attended Rice Institute, where he received his bachelor of science degree in mechanical engineering. He started with Humble in February, 1935, in the engineering department.

George Robinson

J. W. Young

H. J. Mason

Economic Design of Pressure Vessels

Article 3—Materials and Construction Factors

In this third article in a series dealing with analytical methods for determining economic design of pressure vessels, the part which materials and construction factors play in design is discussed. Different operating conditions are assumed for a given size tank and it is pointed out how various grades of steel affect construction costs. The next article in the series will discuss "External Pressure Vessels".

*By E. F. Brummerstedt**

IN THE design of pressure storage tanks, reaction chambers and other vessels operating under either high pressures or temperatures, or both, questions often arise concerning the overall economy of various materials and construction factors. What type of steel should be used? Should the welded joints be stress relieved and/or radiographed?

In order to answer these questions, an analysis was made of the various costs for a typical pressure vessel, 10 ft. 0 in. I. D. by 50 ft., 0 in. long, with 2:1 ellipsoidal heads, but no attachments included. To bring out all possible combinations and their comparative costs, the analysis in Table I is presented for three different design conditions. Unit material costs are based on published standard steel plate extras. Labor costs for forming and welding five courses are based on the Foster Wheeler Carteret Welding shop data, which is representative of the industry in general.

From the accompanying tabulated analysis, the following conclusions can be drawn:

Case I

1. The use of firebox instead of flange quality steel is economical if it reduces the plate thickness by 1/16 in. or more.

2. Aside from technical and delivery considerations, stress-relieving is economically justifiable if it reduces the plate thickness by 1/16 in. or more. It is mandatory if the plate thickness exceeds 1¼ in. without stress-relieving (column B). In certain services stress-relieving appreciably reduces the rate of corrosion and hence would be mandatory from both an economical and technical viewpoint, regardless of reduction of initial plate thickness.

3. Aside from technical and delivery considerations, radiographing is economically justified if it reduces the plate thickness by ⅛ in. or more. It is mandatory for A-212 steels over 1 in. thick.

4. The use of high-tensile A-212 steel results in a considerable weight reduction, but does not appreciably reduce the cost, provided A-70 plate for same design does not exceed 2 in. in thickness. It also requires a special welding technique, including preheating.

Case II

Herein A-70 steel is over 2 in. thick, resulting in high gauge and normalizing extras. These extras for A-70 steel make the use of A-212 steel about 20% cheaper, as well as permitting considerable weight reduction.

Case III (High temperature reaction chambers)

Note that both A-70 and A-212 steels have identically low allowable stresses at this temperature (950°F.) Here a low alloy carbon-molybdenum steel is required as it retains a fairly high allowable stress. All grades (A, B and C) have the same allowable stress at this temperature, although their minimum tensile strengths at room temperatures vary from 65,000 psi for A to 75,000 psi for C. These different tensile strengths are reflected in higher allowable stresses at temperatures below 950°F. (see Table 1, A.P.I.-A.S.M.E. Code, 1943 Edition.

At temperatures between 750° and 950°F., A-204 Grade C steel would be most economical, although the saving would be proportionately less for the lower ranges than the 30% shown for 950°F.

In addition to the steels mentioned above, several other types are used for special services, which cannot be easily reflected in an economic analysis.

Silicon-killed carbon steel per A.S.T.M. A-201 specifications is used for high temperatures and low pressures to provide slightly higher resistance to creep than A-70 firebox steel, although no higher allowable stresses for this, as well as A-212, are permitted by the A.P.I.-A.S.M.E. Code.

The more conservative A.S.M.E. Code allows 3800 psi stress for A-201 as well as A-212 at 950°F., as against only 2600 psi for A-70. (Refer to Table U-2, 1943 Unfired Pressure Vessel Code). Unit cost of A-201 steel is the same as for A-212.

For extremely low temperatures a low-carbon nickel alloy steel per A-203 specifications is ordinarily used. This contains from 2 to 2¾% nickel, which raises its unit cost to slightly more than that of A-204 steel.

Other low-alloy steel plates of high tensile strength only occasionally used for pressure vessels are chrome-manganese-silicon (CMS) steel per A-202 (A.S.M.E. S-28) specifications, and manganese-vanadium per A-225 (A.S.M.E. S-60) specifications. Neither of these is as suitable for high temperatures as A-204, however, and at low temperatures could not economically compete with A-212, hence their use is justified only in special cases.

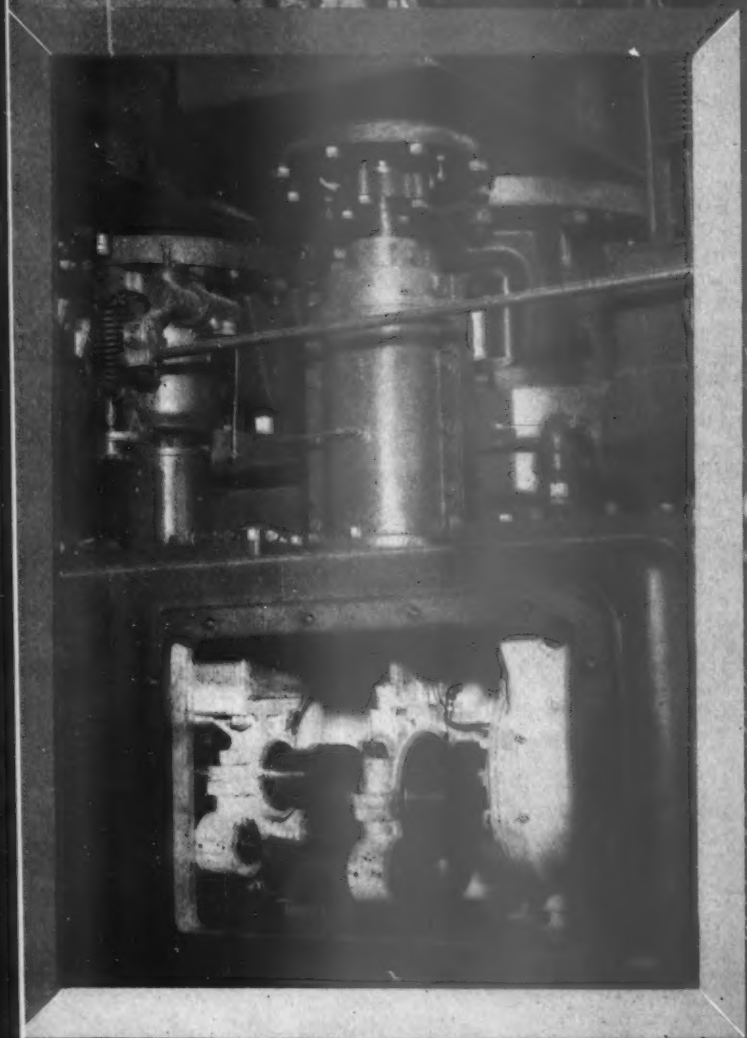
Economic welding design has been covered in many welding manuals and bulletins and requires no further discussion. Each welding shop and construction crew has undoubtedly formulated its own methods and standards through experience and experimental tests, and such a broad field cannot be properly covered within the scope of this analysis.

*Petroleum Refinery Division, Foster Wheeler Corp., New York.

TABLE I—Comparison of Economic Materials and Construction Factors (A.P.I.-A.S.M.E. Code)

Variable Item	CASE I (A-E) Tank—10 x 50 ft. Design Pressure—200 psi Design Temperature—650°F. Corrosion Allowance—⅛ in. A	B	C	D	E	CASE II (F-G) Tank—10 x 50 ft.; Design Pressure—400 psi; Design Temp.—650°F.; Corrosion Allowance—¼ in. F	G	CASE III (H-J) Tank—10 x 50 ft. Design Pressure—200 psi Design Temperature—950°F. Corrosion Allowance—⅛ in. H	I	J
1. Steel Spec., A.S.T.M.	A-70	A-70	A-70	A-70	A-212	A-70	A-212	A-70	A-212	A-204
2. Grade and Quality	Firebox	Flange	Firebox	Firebox	Firebox "B"	Firebox	Firebox "B"	Firebox	Firebox "B"	Firebox A, B, C
3. Min. Tensile Strength, psi	55,000	55,000	55,000	55,000	70,000	55,000	70,000	55,000	70,000	(65,000-75,000)
4. Allowable Stress, psi	13,750	13,750	13,750	13,750	17,500	13,750	17,500	4,950	4,950	10,000
5. Stress Relieve	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. X-Ray (Radiograph)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Joint Efficiency, %	.80	.82	.85	.95	.95	.95	.95	.95	.95	.95
8. Thickness, in.	1¼	1¼	1 7/16	1 7/16	⅞	2⅛	1¾	2¾	2¾	1 7/16
9. Weight, lbs	100,000	100,000	95,000	85,000	71,000	170,000	140,000	220,000	220,000	115,000
10. Unit Material Cost, $/cwt	2.75	2.60	2.75	2.75	3.50	3.85	3.50	3.85	3.50	5.20
11. Total Material Cost, $	2,750	2,600	2,615	2,340	2,490	6,550	4,900	8,470	7,700	5,980
12. Labor and Overhead, $	3,250	3,250	3,100	3,000	2,810	4,850	4,350	5,800	6,050	3,850
13. X-Ray and Stress-Relieving Cost, $	.....	250	250	600	600	800	700	900	900	650
14. Total Cost F.O.B. Shop, $	6,000	6,100	5,965	5,940	5,900	12,200	9,950	15,170	14,650	10,480
15. Cost Comparison, %	100	101.6	99.5	99.0	98.3	100	81.5	100	96.7	69.2

In America's Largest



Detail of valve gear and governor on Ajax vertical steam power cylinders—built for the Clark Compressor installations at Neches Butane.

Butadiene plant...

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Ajax IRON WORKS

CORRY, PENNSYLVANIA

Experience of the Army with lubrication of automotive equipment under extreme service conditions has led to the standardization on heavy duty oils for all engines of Ordnance vehicles, both Diesel and gasoline.

Two additional tests not required for commercial vehicles have been found necessary in Army service and are included in its specifications. One is for what is termed stable pour point, to determine the ability of the lubricant to maintain its pour point after exposure to sub-zero fluctuating temperatures. The second is a non-foaming requirement for S.A.E. 30 and 50 grades, to insure against excessive foaming.

The early portion of the paper, which is omitted, describes the experience of the Army with lubricants leading to the general adoption of additive type oils to secure the desired characteristics of detergency and high resistance to corrosive action.

Development of Heavy-Duty Oils for Military Vehicles*

*By Capt. W. B. Bassett***

Army trucks now use the Alcan Highway in sections of Alaska where ground travel before the war was by dog sled for much of the year. Operation of automotive vehicles at the low temperatures experienced creates severe conditions for their lubricants

DURING the latter part of 1939, and throughout 1940, a great number of the oil companies introduced commercially additive type oils possessing all of these desirable characteristics (detergency and high resistance to corrosive action). Because they were particularly suitable for heavy-duty service, they were commonly referred to as "heavy-duty" oils. In view of their superior performance characteristics when compared to straight mineral oils, they were widely recommended by the automotive manufacturers and the oil industry and most of the large transportation companies, both truck and bus, adopted them. Contractors operating a wide variety of makes and types of equipment, both gasoline and Diesel, found them highly advantageous and much more satisfactory than the straight mineral oils.

During 1941 a few companies actually introduced these heavy-duty oils as their premium grade motor oil for passenger car trade. It is safe to assume that had the war not interfered, other major oil companies would have taken similar action. However, since most of these heavy-duty oils utilized additives prepared from chemicals, which at times have been critical, their sale to the general public was prohibited early in 1942. Sufficient quantities, however, are still available for commercial purposes and being used by transportation companies and contractors. This was the background of commercial experience with heavy-duty engine oils.

Early in 1941 there were no standard lubricants for U. S. Army vehicles. This resulted in frequent misapplication of types and grades of lubricants and would have resulted in a serious supply problem as the Army expanded. The Ordnance Department, therefore, initiated action to standardize on straight mineral, Navy symbol oils for use in gasoline engines and on those oils meeting both Caterpillar and General Motors requirements for Diesel engines.

On Sept. 3, 1941, the Ordnance Department met with representatives of both engine manufacturers and refiners to discuss a specification for Diesel engine lubricating oil. Excellent agreement was reached on all details and as a result U. S. Army Specification 2-104 was published. This included provisions for the qualification of oils prior to procurement, using the laboratory engine tests developed by the Caterpillar Tractor Co. and General Motors Corp. The specification provided for only the SAE Grade 10 and Grade 30.

Bearing Problem Arises

As the military operation of motor vehicles increased in both extent and severity, it developed that alloy bearings in many of these engines were subject to corrosion with the uninhibited straight mineral oils. This paralleled commercial experience and it was apparent that the heavy-duty oils which had proven satisfactory for commercial operation, and which were defined by U. S. Army Specification 2-104 for Diesel engine lubricating oil, were the most suitable for all engines under all operating conditions. Through extension of this specification to cover all engine oils not only could the corrosion of alloy bearings be controlled, but maintenance of the engines would be markedly improved through elimination of objectionable deposits.

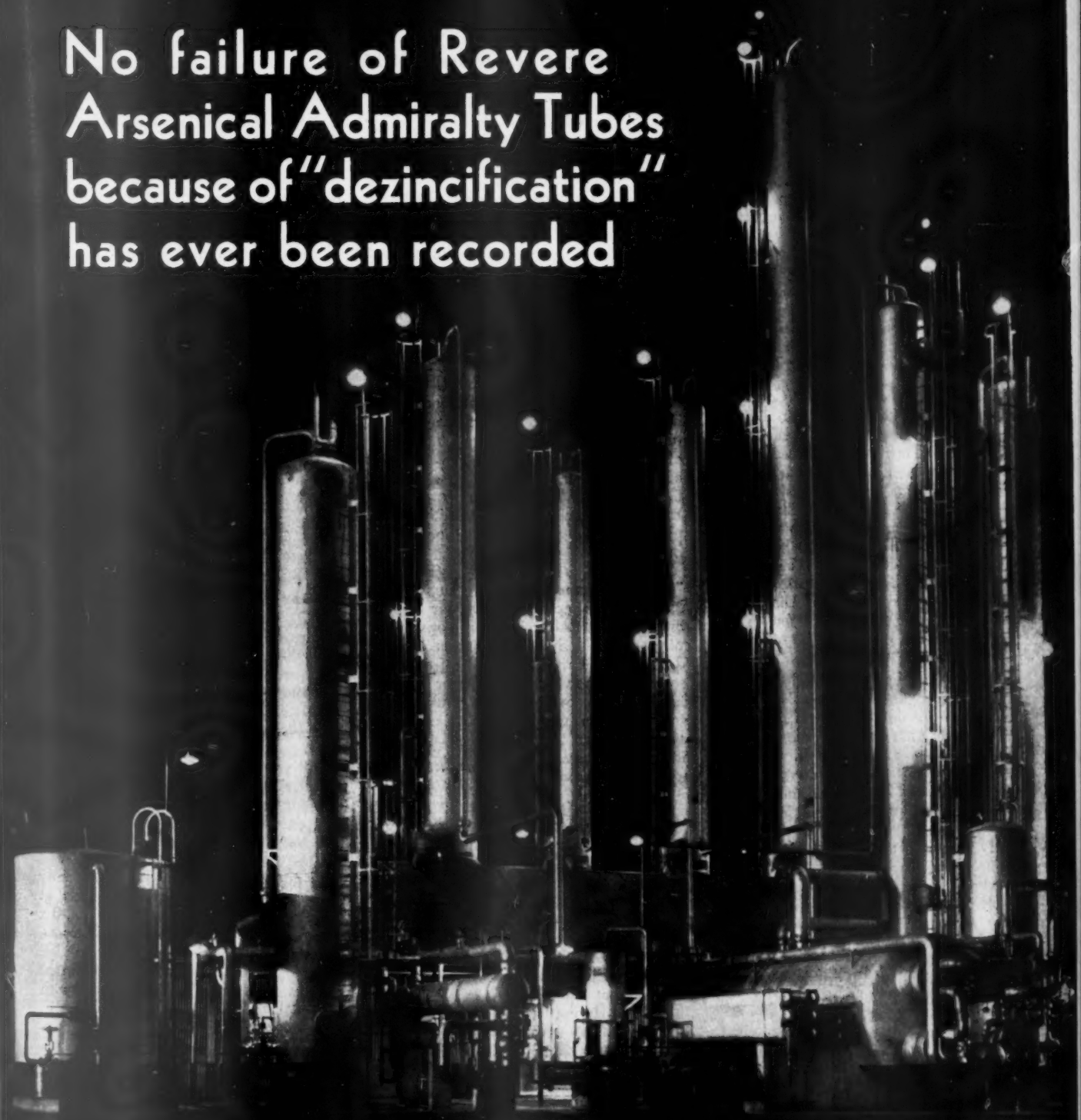
Accordingly, it was decided to standardize on the heavy-duty oils for all engines of Ordnance vehicles. U. S. Army Specification 2-104 was modified to provide for the SAE 50 grade, as well as the SAE 10 and 30 grades, and became U. S. Army Specification 2-104A. Qualification under this specification followed the commercial practice where the oil supplier obtained approvals independently from the Caterpillar Tractor Co. and General Motors Corp. following the separate test procedures of each of these companies. The results of these tests were taken as a basis for the qualification list maintained by the Ordnance Department.

As the critical situation developed with respect to additives and certain base stocks used in heavy-duty oils, necessitating many modifications and requalifications, it became evident that direct Ordnance Department supervision was necessary to insure an adequate supply of satisfactory lubricants at all times. The specification was again revised, becoming U. S. Army Specification 2-104B and provided for direct supervision of all qualification programs. Under this revision the Ordnance Department advises the refiner the engine tests required for qualification, and the tests parts and data are subsequently submitted to a reviewing committee composed of representatives of the Caterpillar Tractor Co., General Motors Corp., Armour Research Foundation and the Ordnance Department. This committee then makes recommendations to the Ordnance Department as to whether the oil meets the

*A portion of a paper presented under this title before the National Diesel-Fuels and Lubricants Meeting of the Society of Automotive Engineers, Chicago, May 17, 1944.

**Project officer on engine oil, Fuel & Lubricants Section, Technical Division, Office, Chief of Ordnance, U. S. Army. On leave of absence from Sinclair Refining Co.

No failure of Revere Arsenical Admiralty Tubes because of "dezincification" has ever been recorded



. . . nor has any case of intercrystalline corrosion ever been observed in commercial installations of these Revere Arsenical Tubes.

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accepted standards for the specified engine tests.

It might be well to discuss briefly the different engine tests required for qualification under the present specification and to explain the importance placed on the evaluation of the different engine parts. These engine tests are the same as those previously used by Caterpillar and General Motors in their respective programs and the procedures have been published by the Coordinating Research Council under their Designations L-1 through L-5.

C.R.C. Designation L-1: Commonly referred to as the Caterpillar 1A test. It is used to determine the effect of a lubricant on ring sticking, wear and accumulation of deposits during a 480-hour period, or in other words, it is a test for detergency. A single cylinder, 5¾ in. x 8 in. Diesel engine is operated under a load of 19.8 BHP for 480 hours with a coolant temperature of 175 - 180°F., and oil to bearing temperatures of 145 - 150°F. Only straight-run Diesel fuel with the characteristics outlined in Appendix A should be used. The oil change periods are 120 hours.

At the conclusion of the 480-hour period there should be no lacquer or other deposits on the piston skirt. Oil rings should, likewise, be free from deposits. Compression rings should show no unusual feathering or sharpness and should be well polished and seated. Some deposits are permitted in the top ring groove to allow for variations in fuel. However, the other grooves should be free from any packed deposits, but may be covered by light lacquer. Needless to say, all rings should be free and show no tendency toward sluggishness. Some piston crown scuffing is allowed, although it should not be deep or severe. The cylinder liner should be well polished and smooth with no evidence of scratching or scuffing, nor should it show any evidence of etching or corrosion.

C.R.C. Designation L-2: Commonly referred to as the Caterpillar "Scratch Test" and used to evaluate the load carrying ability of the lubricant under accelerated run-in and high load. The test is conducted in the same single-cylinder Diesel as is used in the L-1, but with a special cylinder head and a different type piston. Water inlet temperature is 140 ± 5°F. for the SAE 10 grade and 175 ± 5°F. for the 30 grade, with an oil to bearing temperature of 140 ± 5°F. for both grades.

The procedure involves a test period of three hours and 20 minutes, with the first ten minutes at no load, the second ten minutes at light load, and the three hours at relatively high load. New liners and rings are used in each test and should scuffing or scratching occur on either of the first two tests a third run is permitted. Inspection is comparatively simple—the rings are either scratched or not scratched—the lubricant either passes or fails. Under the specification, all of this type test are run at Armour Research Foundation.

C.R.C. Designation L-3: Often referred to as the Caterpillar "Hot Box" Test since the engine is operated either in a "hot box" or with a shroud around the radiator fan to provide the high intake air and jacket temperatures specified. The test is intended to evaluate stability and bearing corrosion. The engine itself is a specially equipped, 4¼ in. x 5½ in., four-cylinder Caterpillar Diesel and is operated for 120 hours without oil change. Load is maintained at 37 BHP with a coolant outlet temperature of 200°F., oil to bearing temperature of 212°F., and air intake temperature of 140°F. For each test the engine is fitted with at least two new cylinder liners, two new piston assemblies and two new copper-lead precision insert bearings.

This test is commonly used as a "screening" run before conducting the longer, more exacting 480-hour single-cylinder test. After 120 hours operation, pistons should show a minimum of skirt deposits. All rings should be free, well seated and show no feathering or scratching. Ring groove deposits are evaluated in much the same manner as in the single-cylinder test. Copper-lead bearing weight losses should not exceed 100 milligrams per whole bearing.

C.R.C. Designation L-4: The well known Chevrolet 36 Hour Test used to evaluate stability and bearing corrosion. The engine is the conventional Chevrolet with 216.5 cu. in. piston displacement and compression ratio of 6.5 to 1. Prior to the test, new piston rings and two new copper-lead bearing inserts are installed. The engine is operated at 3150 RPM with a load of 30 BHP and jacket outlet temperature of 200°F. For the SAE 10 grade, oil temperature is held at 265°F. and for the SAE 30 to 50 grades at 280°F. It is important that the fuel used contain 2.5 — 3.0 ml. tetraethyl lead per gallon. Performance of the lubricant is judged by examination of the power section for deposits, by weight loss of the test bearings, and by inspection of used oil samples taken near the middle and at the end of the test.

For evaluation under U. S. Army Specification 2-104B, this test is used primarily to indicate resistance to corrosion. It is difficult to place an exact limit on allowable bearing weight losses, because of variations in operating technique. Where such weight losses exceed 300 - 350 milligrams per total bearing, the inspection is more critical and often results in a request for additional tests on reference oils of known performances. Because of the high oil temperature, any tendency toward lacquer formation will usually be reflected by piston skirt deposits. Lubricants are rejected which show any such deposits on piston skirts.

C.R.C. Designation L-5: The GMC 500-Hour Test conducted in the model 71 Diesel, used to evaluate oxidation resistance and to some extent the detergency of a lubricant. This test is used for study of the SAE 30 grade and, under the specification, is only employed to evaluate new additives on which no previous data are available. The engine is fitted with at least one new piston and two new copper-lead bearing inserts for each test. New compression rings and oil rings are used on each piston. The engine is operated at 2000 RPM with an output of approximately 26 BHP per cylinder. Water outlet temperature is maintained at 180°F. with oil consumption controlled within specified limits. Oil is not changed for the entire test period of 500 hours.

Upon completion of the test, all parts of the engine are inspected and particular emphasis placed on ring sticking, ring groove deposits, piston skirt deposits, port clogging and bearing corrosion. Because of the severity of this test, Mr. H. C. Mougey has said that any oil which can complete the 500 hours without ruining the engine must be pretty good, although as a member of the Ordnance Reviewing Committee, he looks the parts over rather carefully even though the product lasts for 500 hours.

This gives an idea of the engine tests used for qualifying and evaluating heavy-duty engine oils. The question has often been raised, "Do all of these Diesel engine tests predict what will happen in gasoline service?" The answer is "Yes." The Ordnance Department has recently completed a series of stability tests at Camp Seeley, Cal., in GMC 2½ tons, 6 x 6, cargo trucks. Several different products, including some of the presently qualified engine oils, were used and were operated without oil change for 5000 miles, with crankcase temperatures held at 280°F. It is not expected that such severe conditions will be encountered in actual military service, but the test was initiated to indicate the margin of safety in the present heavy-duty engine oils. With one exception, all engines operated on 2-104B oil were in unusually good condition. No deposits were evident on pistons and all rings were free. No sludge had accumulated in any of the engines. One oil did show evidence of corrosion and from used oil analysis this took place after 3000 miles of operation. As previously explained, the 36-Hour Chevrolet Test has been used to evaluate bearing corrosion and an investigation is now under way to determine whether more strict interpretation of the results, or possibly a change in test procedure, are necessary to properly evaluate the type product which was the exception.

This stability test at Camp Seeley is but one of the engine oil projects carried out under the supervision of our office—the Fuels and Lubricants Section, Technical Division, Office, Chief of Ord-

nance. Unfortunately, time does not permit a discussion of all the work now being done and, in addition, some of the projects are classified and could not be discussed in an open meeting.

However, it would be appropriate to discuss with you two of these projects, which have resulted in additional requirements for qualification under U. S. Army Specification 2-104B. These are:

1. Stable Pour Point for the SAE 10 grade, and
2. A non-foaming requirement for the SAE 30 and 50 grades.

Such changes and almost all of the work done by our office, not only on engine oil, but on all products, have been dictated by performance in all types of operation and under all conceivable conditions. Those changes not dictated by service experience are initiated in anticipation of changing engine requirements.

Pour point is usually determined by an A.S.T.M. method in which the test sample is progressively moved from one bath to another, each of which is maintained at a lower temperature. When the oil sample becomes solid, the pour point is recorded. This evaluation of fluidity meets all the requirements of commercial and civilian operation where atmospheric temperatures are not abnormally low; and when temperatures of —20°F. and —30°F. are experienced, garages and other types of shelter are usually available. This situation does not exist with the armed forces. Vehicles are often exposed for several days to temperatures of —40°F. and lower, and unless some means is provided to insure oil flow at the time of starting serious damage can be expected.

The first step to provide a fluid lubricant at these low temperatures, was dilution with gasoline or low pour point Diesel fuel, the exact amount depending on the anticipated temperatures. To some individuals, the thought of intentionally diluting the crankcase oil with gasoline is unsound and conducive to trouble. From personal observations, the use of gasoline in the crankcase does not interfere with satisfactory operation nor does it produce harmful effects in the engine. One popular make Army truck was operated over a 1000-mile test period with gasoline dilution maintained at 30%. Engine parts were in excellent condition when the engine was dismantled for final inspection.

During the winter of 1942-3, the common practice along the Alcan Highway and the Ordnance Winter Proving Ground was to dilute the crankcase lubricant with one quart of gasoline for each 5 quarts of oil. Operation the following day would usually reduce the gasoline concentration, through boil-off, to about 4% after 3 or 4 hours of convoy service. The engine oils were rediluted every night and during a 1000-mile period as high as 12 - 15 quarts of gasoline might be added to one engine. Subsequent inspection showed no harmful effects, no excessive deposits nor evidence of scoring, and the vehicles could be started each morning with temperatures down to —50°F. provided a warm battery was available.

A peculiar phenomenon was noted, however, both on the Alcan Highway and at the Winter Proving Ground. Some engine oils, both diluted and undiluted, would show a higher pour point after exposure to sub-zero fluctuating temperature cycles than had originally been indicated by laboratory determination This is commonly described as pour point "reversion." By the careful selection of base stocks and by using the proper amount of pour point depressants, it was known that this reversion could be controlled to an absolute minimum. The problem, therefore, was to develop a laboratory pour point test which would properly evaluate this characteristic.

New Pour Point Test

Following the procedure on matters of this type, our office requested the technical assistance of a Co-ordinating Research Council Working Group, sponsored by the American Petroleum Institute and the Society of Automotive Engineers. A study was initiated to determine a suitable test method and applicable limits to evaluate pour point reversion. After careful correlation with service experience, a test procedure and an applicable limit were developed and are now included as a qualification requirement for the SAE 10 grade. Briefly, the procedure, as published under C.R.C. Designation L-11-1143, is as follows:

> A sample of the oil to be tested is diluted with 20% A.S.T.M. naphtha. The diluted sample is then held at the actual pour point for three hours followed by overnight at 20°F. This schedule is repeated for two days. After three hours at the actual pour point on the third day the sample is held overnight at —20°F. and on the morning of the fourth day the stable pour point is recorded as that temperature below which the oil is solid. By specification the maximum stable pour point must not be higher than —40°F. The test method is actually a laboratory reproduction of what might be expected in service although the test temperatures are exaggerated to provide a maximum margin of safety.

The second new requirement is that the SAE 30 and 50 grades shall not produce excessive foam during operation. When engine oils are agitated in the presence of air, foam will result. This was not a particular problem with straight mineral oils, but evidently some of the additives used in the heavy duty oils tend to stabilize this foam, and the problem became quite serious, particularly in dry sump engines.

This project was handled in much the same manner as the stable pour point. The technical assistance of the Coordinating Research Council was again requested and a panel of some 15 representatives of industry co-operated in the test work. Samples were distributed to the co-operating laboratories and to two Ordnance Proving Grounds. In the laboratories the samples were evaluated by several different methods and at the Proving Grounds in several types of Ordnance engines under all types of operating conditions. As a result of this work, a test method and applicable limits were developed and are now included as a qualification requirement for the SAE 30 and 50 grades. The test procedure is relatively simple.

Clean, dry air, at a rate of 0.2 cu. ft. per hour, is bubbled through a diffuser stone immersed in 190 ml. of oil in a one-liter graduate. Air is bubbled through the oil for 5 minutes and foam height recorded after a 10-minute collapse period. Two samples are used in three sequences. In Sequence 1, the test temperature is 75°F., and foam shall not exceed 300 ml. after the 10-minute collapse period. In Sequence 2, the second sample is tested at 200°F., and foam shall not exceed 25 ml. after the 10-minute collapse period. Following Sequence 2, the same sample is cooled to 75°F., in the same graduate, and Sequence 3 conducted. Foam after 10 minutes of collapse shall again not exceed 30 ml. These values for foam collapse are the result of careful correlation of laboratory tests and service tests. Effective March 10, 1944, all SAE 30 and 50 oils supplied under U. S. Army Specification 2-104B must be foam inhibited.

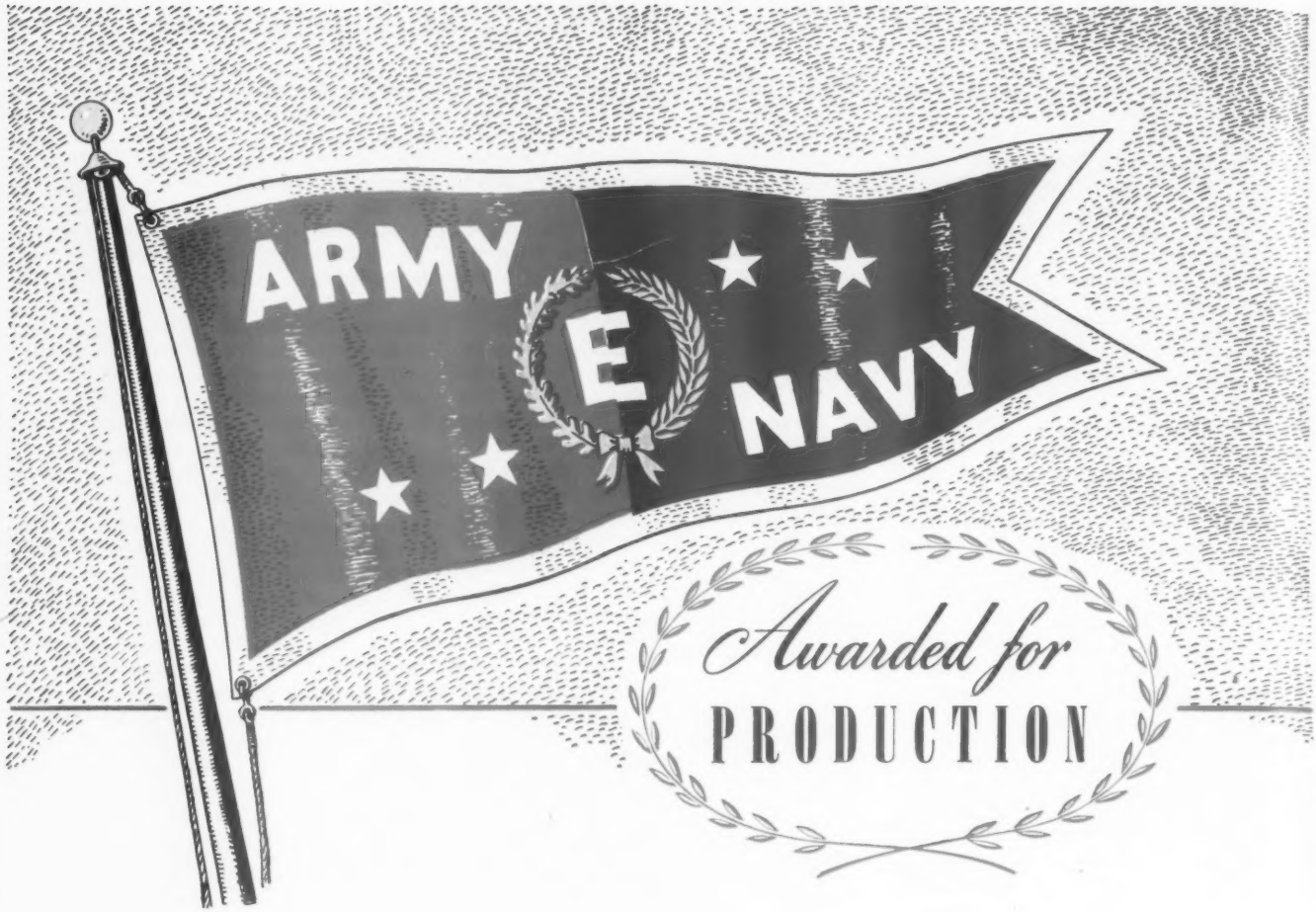
Field experience with the heavy-duty engine oils meeting U. S. Army Specification 2-104B has been most satisfactory, from operations in the desert to operations at sub-zero temperatures. Reports are consistent as to general engine cleanliness and freedom from corrosion and ring sticking. The use of this type product has been reflected in increased engine life and longer periods between

Appendix A

(Diesel Fuel Specifications for U. S. Army Specification 2-104B Engine Qualification Tests.)

Type	Straight-Run
Flash, min.	100°F.*
Pour Point, max.	20°F.
Water & Sediment (vol.) max.	0.05%
Carbon Residue on 10% residuum, max.	0.20%
Ash, max.	0.01%
Distillation	
90% point, min.	550°F.
max.	600°F.
End point, max.	675°F.
Viscosity, Kinematic	
Centisokes at 100°F., min.	1.6
max.	4.5
Sulphur, max.	0.40%
Corrosion	pass
Alkali and Mineral Acids	none
Cetane Number, min.	43
max.	53

*Or legal.



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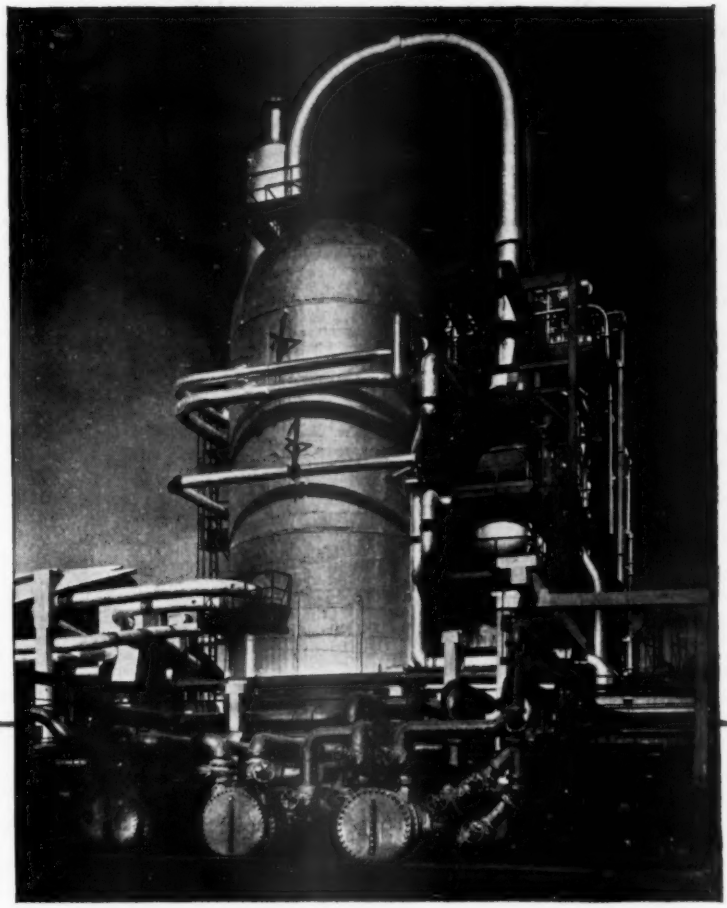

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overhaul. We are confident that the use of these oils is an important factor in our present operations and know that they can be depended on in future operations, under all conditions.

I would like to express our gratitude to the Co-ordinating Research Council and to the members of the oil and automotive industry, who have so generously contributed their time and facilities toward the development of our present heavy-duty engine oils.

Engine Oil, U. S. Army Specification No. 2-104B As Issued May 6, 1943, including Amendment of Jan. 15, 1944

(Condensed from official text but containing complete text of all sections having to do with properties of the lubricant.)

B. GRADES.

B-1. Engine oil shall be of three viscosity grades designated as SAE 10, SAE 30 and SAE 50.

C. MATERIAL AND WORKMANSHIP.

C-1. Engine oil shall be a refined petroleum product with or without additive agents.

D. GENERAL REQUIREMENTS.

D-1. Engine oil shall be non-corrosive to bearings and engine parts, shall not cause or permit piston ring sticking or clogging of oil channels and shall minimize cylinder and ring wear. This engine oil shall provide satisfactory lubrication of high speed, automotive type gasoline, Diesel, or spark ignition fuel engines when operated under all conditions of service. Additive agents, if used, shall not appreciably increase the tendency of the base oil to foam.

D-2. Additive agents, if used, shall remain uniformly distributed throughout the oil at all temperatures above the pour point up to 250° F. If the oil is cooled below its pour point, it shall regain its homogeneity on standing at a temperature of not more than 10° F. above the pour point of the oil.

E. DETAIL REQUIREMENTS.

E-1. **Qualification.** Engine oils furnished under this specification shall be of a grade or grades which have been tested and found suitable for the purpose intended as determined by the "Qualification" tests in section F (See paragraph H-1).

E-2. Engine oils covered by this specification shall be in accordance with Table I.

TABLE I

TEST	TEST LIMITS Grade SAE 10	Grade SAE 30	Grade SAE 50
Viscosity, Saybolt universal			
Seconds at 130° F.	90 to less than 120	185 to less than 255	.....
Seconds at 210° F.	.....	.....	95 to less than 105
Viscosity Index, minimum	85	55	75
Pour Point, °F., maximum	minus 10	0	15
Pour Point after dilution with 20 per cent Precipitation Naphtha, °F., maximum	minus 40	minus 40	.....
Flash Point, °F., minimum	360	390	400

E-3. **Flash Point.** The minimum flash point of Grade SAE 50 before the addition of any additive shall be 450° F.

E-4. **Control Limits.** For purposes of product identification, the bidder shall state in his bid the suitable control limits of the oil he proposes to furnish, as regards the following:

Gravity, API
Carbon Residue, per cent
Sulphur, per cent
Phosphorus, per cent
Chlorine, per cent
Ash, per cent
Components of Ash, per cent, and such other tests as he may consider desirable for identification purposes.

F. METHODS OF SAMPLING, INSPECTION AND TESTS.

F-1. **Sampling.** Samples shall be taken according to the procedure described in Federal Specification VV-L-791 of the issue in effect on date of invitation for bids. The number and disposition shall be in accordance with the terms of the contract.

F-2. **Laboratory tests.**

F-2a. Unless otherwise specified herein, the following tests shall be made in accordance with Federal Specification VV-L-791 or with the following ASTM specifications, or latest revisions thereof.

TABLE II

Test	TEST NUMBER Federal	ASTM
Viscosity Index	911.1	D567-41
Gravity	40.11	D287-39
Viscosity	30.44	D88-38
Pour Point	20.16	D97-39
Flash Point	110.33	D92-33
Carbon Residue	500.14	D189-41
Ash	542.11	D482-38T
Sulphur	520.23	D129-39

F-2b. **Additional Analyses.** The right is reserved to make such additional analyses and tests as may be directed by the War Department agency responsible for the supervision of procurement (see paragraph H-2) to determine that the oil supplied complies with all requirements of this specification and those stated by the contractor in his bid (see paragraph E-4).

F-3. **Qualification Tests.** All engine oil procured under this specification shall be tested for qualification as follows:

F-3a. Unless otherwise specified, the qualification tests shall be made in accordance with Table III (see paragraph H-1).

TABLE III

Required when the finished engine oil uses an additive not previously used in an engine oil qualified by the Ordnance Department.	Required when the finished engine oil uses an additive previously used in an engine oil qualified by the Ordnance Department.
SAE 10 Grade	**SAE 10 Grade**
1. CRC-Designation-L-1-1143	1. CRC-Designation-L-1-1143
2. CRC-Designation-L-2-1143	2. CRC-Designation-L-2-1143
3. CRC-Designation-L-3-1143	3. CRC-Designation-L-4-1143
4. CRC-Designation-L-4-1143	
SAE 30 Grade	**SAE 30 Grade**
1. CRC-Designation-L-1-1143	1. CRC-Designation-L-1-1143
2. CRC-Designation-L-2-1143	2. CRC-Designation-L-2-1143
3. CRC-Designation-L-3-1143	3. CRC-Designation-L-4-1143
4. CRC-Designation-L-4-1143	
5. CRC-Designation-L-5-1143	
SAE 50 Grade	**SAE 50 Grade**
1. CRC-Designation-L-4-1143	1. CRC-Designation-L-4-1143

F-3b. **Additional Tests.** Engine oil shall be subject to such other tests, in addition to those listed in Table III, as may be prescribed by the War Department agency responsible for supervision of the qualification tests (see paragraph H-1).

F-3c. **Compatibility.** Determination shall be made of the compatibility of the engine oil with all other engine oils previously procured under this specification (see paragraph H-1).

F-3d. **Stable Pour Point.** The SAE 10 grade shall be tested in accordance with CRC Designation L-11-1143 and the stable pour point by that method shall not exceed a maximum value of —40° F.

F-3e. **Foaming.** The SAE 30 and SAE 50 grades shall be tested for foaming characteristics in accordance with CRC Designation L-12-1143 and shall not exceed the following values for the indicated sequence:

(1) Sequence 1. No limit immediately following the bubbling period but a maximum of 300 ml. after 10 minutes of foam collapse.
(2) Sequence 2. No limit immediately following the bubbling period but a maximum of 25 ml. after 10 minutes of foam collapse.
(3) Sequence 3. No limit immediately following the bubbling period but a maximum of 300 ml. after 10 minutes of foam collapse.

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. Packaging and packing shall be in accordance with U. S. Army Specification No. 100-13 except as given in paragraph G-2.

G-2. **Marking.**

G-2a. **Containers.** Unless otherwise specified, containers shall be marked with the symbol number, the Standard Army Nomenclature, specification number, name of the company and qualification number, as follows:

OE-30 (or 10 or 50) — Qualification number
OIL, ENGINE, SAE 30 (or 10 or 50). — Date of filling
U. S. A. Spec. No. 2-104B — Net contents
Name of Company — Contract number

G-2a(1). All containers manufactured from terne plate shall be lithographed on one side above the marking as follows:

(POISON)
Not to be used as food container.

G-2b. **Shipments.** Shipments shall be marked in accordance with Specification No. 100-2, or as specified in the contract or order.

H. NOTES.

H-1. The right is reserved to reject any bids on Oil, Engine, which have not been subjected to the required qualification tests and found satisfactory. The attention of the manufacturers is called to this requirement and they are urged to conduct qualification tests of the oil they propose to offer in accordance with this specification. It should be noted that a previously qualified product in which any change is made in additive or base stock must be qualified as a new product. Information as to whether an additive has been previously qualified in engine oils may be obtained from Office, Chief of Ordnance, War Department, Washington, D. C.

Qualification tests may be conducted in any plant or laboratory approved by the Ordnance Department except the compatibility, the CRC Designation L-2-1143, and the final evaluation testing for stable pour point and foaming, all of which will be conducted at Armour Research Foundation, Chicago, Illinois.

It should be understood that the cost of all the qualifying tests are to be borne by the prospective supplier regardless of where such tests are made. Information as to the procedure for the qualification of engine oils under this specification may be obtained from the Service Branch, Technical Division, Office, Chief of Ordnance, War Department, Washington, D. C.

H-2. Information regarding procurement under this specification may be obtained from the Fuels and Lubricants Division, Office of the Quartermaster General, War Department, Washington, D. C.

H-3. The contracting officer, in making decisions regarding compliance with the requirements of paragraphs D-1 and E-1 should be guided by the list of qualified oils maintained by the Ordnance Department.

H-4. The use of this specification, whenever applicable, is mandatory on all procuring agencies of the Army.

Present and Future Trends in Motor Fuels*

Relationship of Molecular Structure of Hydrocarbons To Engine Requirements Is Basis for Research Study

Fundamental data concerning the properties of selected hydrocarbon compounds in the gasoline range have been developed in the course of the American Petroleum Institute Hydrocarbon Research Project. The data here reported describe the relationship of molecular structure to engine characteristics. Octane numbers of selected paraffins were plotted against their carbon content and the effect shown of changing the straight-line structure to that of analogous isomer compounds. In the five and a half years of operation of the project, 116 hydrocarbon compounds have been examined and 17 additional hydrocarbons are in course of production.

*By Cecil E. Boord***

Several years ago a well-known automotive engineer asked his chemical associates the question: What is in a gallon of gasoline? This question cannot be answered specifically. It is not sufficient to say gasoline is composed of a mixture of hydrocarbons boiling in the range between the average daily temperature and 420°F. Gasoline in one part of the country does not have the same composition as the gasoline in another part. The gasoline produced from a Pennsylvania crude contains a high percentage of paraffins, while the gasoline produced from a California crude contains a high proportion of naphthenes. The gasoline from a Mid-Continent crude contains appreciable amounts of both paraffins and naphthenes.

Not only does the composition of crude and its products vary from one geographical location to another but different pools in the same region vary among themselves. Some pools in the Mid-Continent field show a very appreciable content of aromatics.

A still greater variation in the composition of motor fuel finds its origin in differences in the methods of refining. Gasoline produced by straight-run distillation may show an octane number from the upper 30s to well above 60. The yield normally lies between 20 and 30% of the crude charged to the stills. Even before the end of World War I the then infant automotive industry was threatened with an early death because of an inadequate motor fuel supply. To meet this emergency the cracking process was born.

In the cracking process the heavy hydrocarbons of petroleum are fragmented by heat and converted into the lighter hydrocarbons of the gasoline range. In this process of making little molecules from the bigger ones not only are the carbon chains ruptured but, to a certain degree, hydrogen is stripped off, leaving the product highly unsaturated. The octane number of the gasoline produced ranges from the upper 50s to well above 70. The yield of motor fuel was pushed steadily upward and the disaster to the automotive industry was at least temporarily averted.

In the quarter century since World War I the refiner has become very skilled in the cracking art. He has learned by the use of catalytic agents and by the control of operating conditions to make his cracking processes yield him what he wants. By analogous processes the low-grade gasolines are *reformed* into products having better engine characteristics.

The large volume of residual gases coming at the end of the cracking still and representing the smaller fragments produced by the cracking process are composed of both saturated and unsaturated hydrocarbons. These are rebuilt by polymerization and hydrogenation or by alkylation into hydrocarbons of the gasoline range. Bigger molecules are remade from the little ones. In effect the cracking process has been reversed.

The octane number of motor fuels has climbed higher and higher. The percentage of the crude which eventually finds its way into motor fuel has moved steadily upward. The refinery combining all of these operations is said to be streamlined.

The scientific and advertising pages of our technical and trade journals are filled with a new terminology. One no longer refers merely to the cracking process but to thermal cracking and catalytic cracking, hydrogenation and dehydrogenation, alkylation and dealkylation, polymerization and depolymerization, reforming and hydroforming, cyclization and decyclization, aromatization and isomerization.

Each of these terms represents a specific

TABLE 1—Contributors to A.P.I. Hydrocarbon Research Project

Members of the advisory committee of the A.P.I. Hydrocarbon Research Project and representatives of contributing concerns (Dr. D. P. Barnard, Whiting, Ind., Associate Director of Research, Standard Oil Co. [Indiana] is chairman of both groups):

Advisory Committee

D. P. Barnard, Standard Oil Co., (Indiana).
George Calingaert, Ethyl Corp.
Gustav Egloff, Universal Oil Products Co.
R. A. Halloran, Standard Oil Co. of California.
W. G. Lovell, Research Laboratories Division, General Motors Corp.
E. V. Murphree, Standard Oil Development Co.

Contributors' Representatives

E. G. Borden, Cities Service Oil Co.
R. E. Burk, Standard Oil Co. (Ohio).
David E. Day, Richfield Oil Co.
F. A. Deering, Kanotex Refining Co.
S. W. Ferris, Atlantic Refining Co.
B. C. Frichot, Deep Rock Oil Corp.
J. Bennett Hill, Sun Oil Co.
G. J. Huebner, Jr., Chrysler Corp.
C. B. Hunter, Quaker State Oil Refining Corp.
W. E. Kuhn, The Texas Co.
R. E. Luton, Ohio Oil Co.
J. T. McCoy, Tide Water Associated Oil Co.
A. E. Miller, Sinclair Refining Co.
C. W. Montgomery, Gulf Research and Development Co.
Roger Newton, Catalytic Development Co.
G. G. Oberfell, Phillips Petroleum Co.
W. E. Perdew, Winkler-Koch Engineering Co.*
J. W. Poole, Lion Oil Refining Co.
J. B. Rather, Socony-Vacuum Oil Co.
W. B. Ross, Pure Oil Co.
L. C. Rubin, M. W. Kellogg Co.
B. I. Scoggin, Anderson-Prichard Oil Co.
D. G. Smith, Anglo-Iranian Oil Co., Ltd.
S. Tijmstra, Shell Development Co.
Don E. Carr, Union Oil Co. of California.
E. J. Mary, Globe Oil & Refining Co.
H. V. Smith, The Barber Co.
J. M. Gardiner, Republic Oil Refining Co.
B. P. Crittenden, Rodessa Oil and Refining Co.
H. B. Lincoln, Continental Oil Co.

*Deceased.

* A portion of a paper under this title presented before the meeting of the Eastern District, Division of Production, American Petroleum Institute, Columbus, O., April 14, 1944.

** Professor of Chemistry, Ohio State University, Columbus, Supervisor, A.P.I. Hydrocarbon Research Project.

phase of the cracking art. When these operations are used in combination with improved methods of fractionation the product may be separated into cuts containing a single hydrocarbon or at most a few individual hydrocarbons. Newer methods of analysis now being developed make it possible not only to identify these individual components but also to determine their percentage with remarkable accuracy.

In 1938 the present author wrote "slowly but surely the range of what may be contained in a gallon of gasoline is being confined to ever narrower limits. The petroleum chemist may see before him as an ultimate goal a chemically pure motor fuel containing a single, individual hydrocarbon."[1] This statement was too Utopian but in the intervening years petroleum technology has reached the point where the original question can be rephrased. He can now return the question to the internal combustion engineer by asking: "What should be in a gallon of gasoline?" To answer this question one must know the engine characteristics of each individual hydrocarbon with certainty. He must have its physical constants and its spectrographic finger prints so that it may be identified, estimated and evaluated both as an individual and as component in admixture with other hydrocarbons.

The American Petroleum Institute Hydrocarbon Research Project was established in 1938 for the specific purpose of accumulating this data. The project has been under the sponsorship of 36 industrial firms including petroleum refiners, development laboratories, automobile manufacturers and manufacturers of refinery equipment. The firms which have contributed for one year or more are listed in Table 1.

In the five and one-half years of operation, 116 compounds have been examined and 17 additional hydrocarbons are in process of production.

Octane Number and Molecular Structure

In a paper[2] presented before the American Petroleum Institute in November, 1942, it was pointed out "The paraffins are to be regarded as a collection of many subseries, the collection growing more numerous and the structure more complex as the number of carbon atoms is increased."

"When the boiling points, densities or refractive indices of the paraffins are plotted against carbon content, a compact family of curves may be drawn, each representing a characteristic structural isomer."

An analogous relationship can be shown to exist between engine characteristic and molecular structure. The octane numbers when measured by the research, motor or other methods are not strictly comparable and the data is therefore fragmentary. Comparisons must be made among selected groups of compounds. Figs. 1 and 2 illustrate two cases in point. Many other groups could be selected. These two are typical.

In Fig. 1 the motor octane numbers of a group of paraffins are plotted against their carbon content. Here again we see segments of a series of curves each representing a particular type of structural isomer. The lower curve, falling from upper left to lower right, represents a portion, C_5 to C_7, of the octane number curve for normal paraffins. Immediately above this and roughly parallel fall analogous curves for the 2-methyl; 2,2′-dimethyl; 2,2-dimethyl and 2,2,3-trimethyl paraffins. As the length of the longest chain is increased the octane number falls[3]. As the number of methyl groups is increased the octane number rises.

The previous article recalled the well-known fact that the melting points of the normal paraffin form an alternating series[4]. Alternation is not apparent in the boiling point curves. But, as was pointed out, the substitution of methyl groups for hydrogen in successive positions along the carbon chain adds alternately larger and smaller increments to the boiling point.

Fig. 1 shows analogous alternation in the octane numbers of the simple paraffins. The alternation is quite perceptive in the curves for the 2-methyl- and 2,2′-dimethyl paraffins. It is very obvious in the curves showing the changes in octane number with an increase in the number of methyl groups as for example: n-pentane—2-methylpentane — 2,2′-dimethylpentane — 2,2,3-trimethylpentane and the corresponding hexane series.

As was stated above, cracking not only fragments the carbon chain producing smaller molecules but also strips off hydrogen atoms introducing unsaturation. The double bonds, resulting by this stripping of hydrogen, may be in the oc, b, y or

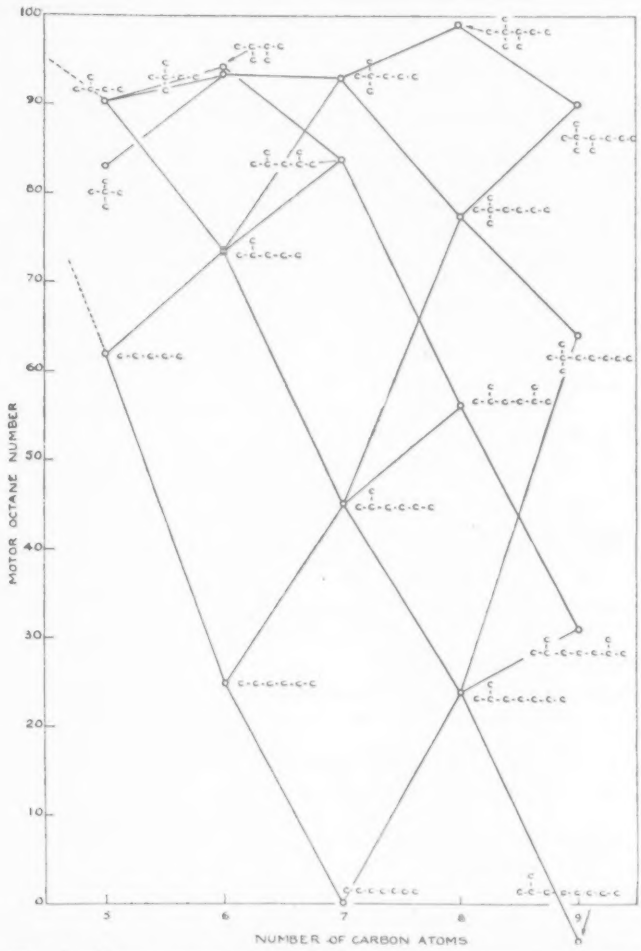

Fig. 1—Motor octane numbers of a group of paraffins plotted against their carbon content

[1] Science of Petroleum Vol. 11 page 1356 (1938).

[2] Oil and Gas Journal 41 (No. 27) 188, 190, 192, 196 (1942), Petroleum Refiner 21 372 (1942).

[3] T. A. Boyd, Oil and Gas Journal, 29 (No. 42) 147, 227 (1931), Egloff and Van Arsdell, Symposium in the Contribution of Petroleum Chemistry to the Automotive Industry, Petroleum Division, A.C.S. Detroit, Page 59, 1940.

[4] Deansley and Carleton, J. Phys. Chem. 45 1104 (1941); see also Kaufmann, *Relation Between Physical Properties and Chemical Constitution*, Ferdinand Enke, Stuttgart (1920).

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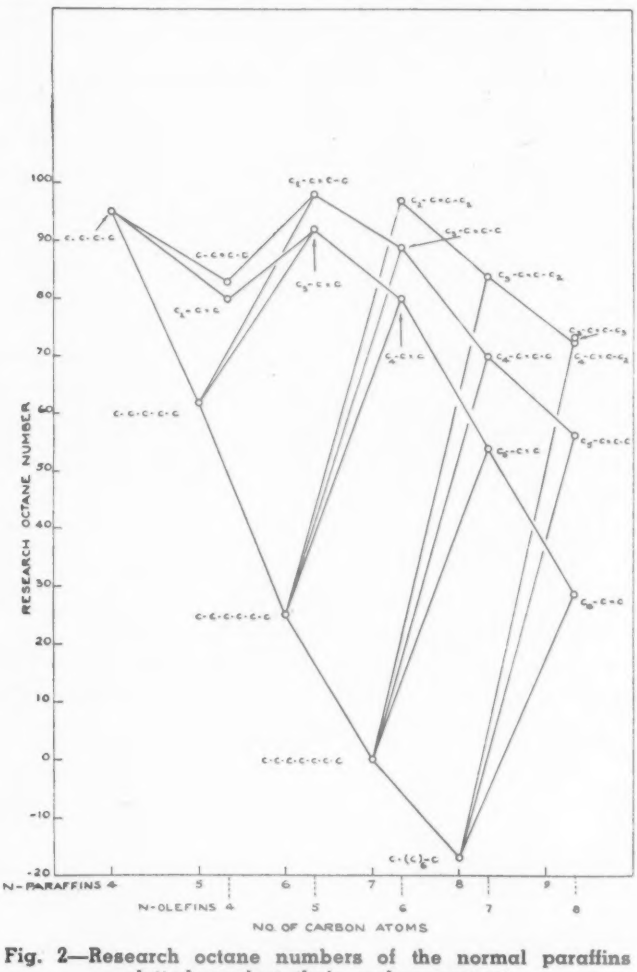

Fig. 2—Research octane numbers of the normal paraffins plotted against their carbon content

other positions. Fig. 2 shows the research octane numbers of the normal paraffins plotted against their carbon content. Offset and above this curve are plotted the octane numbers of the corresponding oc, b and y-olefins. It is immediately obvious the introduction of unsaturation greatly increases the octane number. The nearer the double bond lies to the middle of the chain the higher its engine characteristics.

Let us now consider the above facts in their relation to modern refining operations. When a heavy paraffin hydrocarbon is submitted to the cracking process smaller molecules are formed and the octane number rises following the curves upward, lower right to upper left in Fig. 1. If at the same time dehydrogenation takes place the octane number is still further increased as shown in Fig. 2.

When a normal paraffin is reformed by isomerization the octane number rises as the degree of branching is increased along the vertical axis, at any given carbon content, Fig. 1. An unsaturated hydrocarbon also may be reformed by isomerization due to a shift in the position of its double bond[5]. If as is usually the case this shift is toward the middle of the chain the octane number is further increased as shown in Fig. 2.

The alkylation of an isoparaffin may be considered as passing from left to right across the family of octane number curves, as in Fig. 1 and similar groups. If a sufficiently high degree of branching is maintained the octane number may be kept high or even increased.

The two groups of curves, shown in Figs. 1 and 2, could be multiplied many times. But the number of hydrocarbons falling within the gasoline range is very high. Furthermore, the internal combustion engine is a very sensitive instrument. Engine characteristics when measured by the research method, the motor method, as blending values or critical compression ratios are not readily converted from one form to the other. The data are, therefore, fragmentary. Data on a larger number of compounds and more data on each compound are needed before a complete and final interpretation can be made. But, slowly and surely, the petroleum technologist is reaching the point where his art will be on a strictly scientific basis.

[5] Henne and Turk, J. Am. Chem. Soc., 64 826 (1942), Henne and Chanan, ibid., 66, (1944).

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Centrifugal Compression Of Hydrocarbon Gases*

High speed centrifugal compressors, or turbo-compressors, may find many applications in the petroleum industry for moving vapor phase fluids.

Simplicity of operation, freedom from wear, and high operating efficiency are some advantages cited in favor of this type compressor. Absence of vibration makes them particularly desirable for natural gasoline recovery operations. Freedom from pulsation will eliminate disturbing troubles in gas metering equipment.

In the following article, the author doesn't attempt a mathematical or thermodynamical treatise on compressors or combustion turbines. He is concerned primarily with explaining their various operating characteristics and advantages, and showing where he believes they may fit into the petroleum picture. "Nothing in this discussion," he states, "is intended to condemn or derate reciprocating equipment, which plays such an important part in our great industry."

*By E. O. Bennett***

THE use of high rotative speed centrifugal pumps for the moving of liquid phase fluids in all branches of the petroleum industry is very general. In fact, one would have to look quite thoroughly to find other than a crankless rotating type machine for liquid pumping in any petroleum industry plant installation placed in operation during the last few years.

The question is often asked, "Is there any reason why high speed centrifugal pumps cannot move vapor phase fluids as well as liquids?" Development during the last few years permits the answer to this question to be, "No."

The same principles of design that are used in centrifugal pump construction are used in the design of centrifugal compressors. The only difference between the two is that the centrifugal pump handles relatively non-compressible fluids, whereas the centrifugal compressor, often called a turbo-compressor, handles compressible fluids.

"There is a tendency among engineers to confuse a centrifugal compressor, either with a rotary compressor or with a reversed steam turbine. It may not be amiss, therefore, to point out that it resembles neither. The rotary compressor is merely a positive compressor with rotary instead of reciprocating pistons and requires either contact parts or sealing liquid, or both. In general it is much more subject to wear than a reciprocating machine, and in most cases requires valves. In general, it is both inefficient and short lived and for this reason its appearance in industry has not been general.

"A mechanism such as the steam turbine cannot be operated effectively in reverse, as a pump, for a reason very similar to the well-known fact that a Pelton wheel cannot be used as a centrifugal water pump. The steam turbine is designed primarily to utilize efficiently the kinetic energy of an expansible fluid, but is not adapted to reverse this process. While the mechanical efficiency of a steam turbine under the best conditions may be 75% or 80%, an attempt to use it in reverse process would result in absurdly low efficiency, making its use uneconomic." (1)

Centrifugal pumps or compressors are designed upon entirely different principles than steam turbines but are capable of giving efficiencies, with proper design, of well over 80%; and it is believed that continued development and use of such units will permit further increases in their efficiencies.

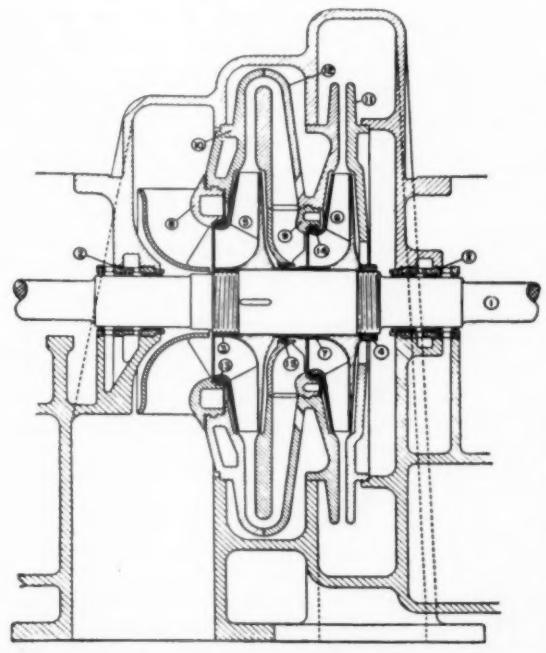
A centrifugal compressor has one feature in common with a turbine: freedom from wear, with the result that it maintains constant efficiency throughout its life. The centrifugal compressor has the same simplicity of operation as a turbine. In addition to these features it is a machine which, when actuated by a suitable prime mover, is capable of transferring energy to a fluid, whether such fluid is in a vapor or liquid phase, with very excellent operating efficiencies.

A centrifugal compressor requires no valves or rubbing surfaces, other than its two main shaft bearings; and its successful operation is not dependent upon extremely close rotating and reciprocating types of gaseous phase pumps or compressors.

The same fundamentals of design enter into both centrifugal pumps and centrifugal compressors except that the centrifugal compressors, due to the necessity of handling compressible fluids of less density than normal centrifugal pumps handling liquids, are in most cases operating at considerably higher rotating speeds. Higher speeds in centrifugal compressors such as those used in turbine practice call for large diameter shafts that make a very rugged type machine. Steel discs are used in the construction of the rotary members to provide adequate strength. Where several stages of compression are required, thin metal labyrinths are used to prevent leakage between stages. Such a labyrinth seal is very effective and is practically frictionless. Such seals have been used in steam turbines for many years, and there is nothing new or radical in their use. No metal contacts exist in the labyrinth seals.

The only parts of a centrifugal compressor subject to mechanical wear are the two main shaft bearings. But with proper design and lubrication the life of a high speed bearing is very great, and the shafts and bearings will retain their

[1]W. H. Carrier, American Society of Refining Engineers, December, 1925.



(1) Shaft
(2) Shaft labyrinth—either end
(3) Impeller lock nut—suction end
(4) Impeller lock nut—discharge end
(5) Impeller—first stage
(6) Impeller—second stage
(7) Impeller spacer
(8) Inlet guide vane—first stage
(9) Inlet guide vane—second stage
(10) Intake wall
(11) Discharge wall
(12) Diaphragm—first stage
(13) Inlet labyrinth—first stage
(14) Inlet labyrinth—second stage
(15) Spacer labyrinth

Fig. 1—Cross sectional view through two-stage centrifugal compressor. Same design principles used in centrifugal pump construction are used in centrifugal compressor design

*Principal portions of a paper of the same title presented before the 23rd annual convention of the Natural Gasoline Association of America, April 12-14, Dallas.

**Engineering consultant, Houston.

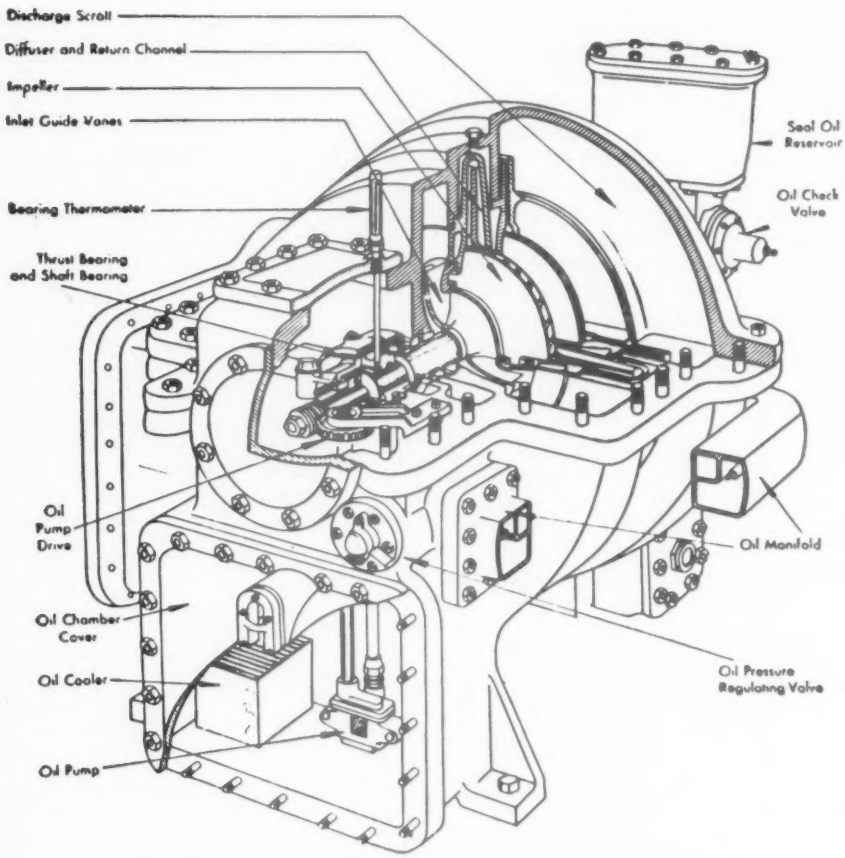


Fig. 2—Cutaway view of typical centrifugal compressor

original dimensions for a great many years. Reciprocating machines of modern design have bearings that last much longer than those of the early machines but cannot begin to compare with the life of high speed centrifugal equipment. Figs. 1 and 2 show sectional and cutaway views of a typical centrifugal compressor.

Due to its simplicity of design and minimized number of wearing parts, the mechanical efficiency of a centrifugal turbine is found to be over 99%. The mechanical efficiency of a reciprocating type unit is somewhat less.

Overall Efficiency Is About 85%

The efficiency curve of a centrifugal compressor is very flat between 50% and 100% volumetric capacity. The overall efficiency of this type unit is approximately 85% at maximum designed load, and falls off slightly if the load, or output volume, is increased or decreased.

The head, or discharge pressure curve, falls off with a capacity beyond the maximum; so, too, does the compression ratio. The machine is primarily a constant head unit; however, the head may be varied by changing the rotating speed.

A machine with the above characteristics is very desirable for gasoline recovery plant operations as the greatest possible uniformity in flowing conditions may be obtained, and shock and vibration will be completely absent. The absence of vibration or pulsation in high pressure lines is extremely desirable in high pressure operations in connection with condensate or natural gasoline recovery, as most pipe failures which occur are from pulsation and vibration. Freedom from vibration and unbalanced dynamic forces lessens the amount of concrete and foundations required for centrifugal compressors and eliminates the difficulties with vibration in field lines, where but few compressor cylinders are used in reciprocating machines.

One of the most disturbing factors in the metering of gas has been pulsations. Centrifugal type machines will entirely eliminate such troubles and minimize wear and tear on metering equipment.

Centrifugal compressors, complete with prime movers, generally steam turbines, are estimated to cost from $65 to $85 per horsepower as compared to $105 to $135 per horsepower for reciprocating equipment with comparable installation quality.

Centrifugal compressors are now built for discharge pressures up to 400 psi; the limiting factor in this regard is the strength of the case. No reason is seen to prevent the design of units suitable for operating up to 3000 psi or more. Cases may be designed for balanced inside and outside pressures and inserted in a sufficiently strong "gun-barrel" outer case. This principle has been successfully used in fluid meters where a 25 or 50 lb meter may be used for pressures up to 3000 psi or more.

The compression ratio of a centrifugal compressor is dependent upon the intake temperature of the fluid being handled, and presently completed designs will operate approximately at ratios shown below:

Fluid Pumped	Four Wheels	Six Wheels
Average Natural Gas	2.4	4.1
Air	2.8	4.5
Propane	7.0	16.0
Butane	10.0	25.0

Higher ratios can be obtained by the use of interstage coolers, for minimizing inlet temperature before the gas passes to successive stages.

Safety Valves Not Required

Peak or designed pressures for a multistage centrifugal or turbo-compressor cannot be exceeded, and destructive pressure due to accidental closure of a valve on the discharge system cannot be developed. For this reason relief equipment such as safety valves or frangible blow out discs are not required, thereby further minimizing installation costs.

A centrifugal compressor has a definite pressure-volume curve for its designed speed, and the pressure-volume relationships will have a separate curve for each rotative speed.

In operation, the gas to be compressed enters the rotating element at apertures around the shaft of the machine. The rotating element imparts velocity to the gas by the centrifugal motion. This velocity increases with the increasing radial speed of the impeller section it passes through until it reaches the discharge tip of the impeller, where the energy due to velocity is converted to pressure energy in passing through the stationary vanes around the impeller. As the velocity is decreased the pressure is increased and the moving volume of gas is carried to the next wheel of the unit, where a second increment of pressure is added by the same process. The final discharge pressure required determines the number of stages required.

Variation in speed for driving centrifugal compressors depends upon the type of prime mover used. Where steam turbines are used for this purpose a wide range is available by throttle control of the turbine. Where constant speed electric motors are used variable compressor speeds may be obtained through the use of an efficient fluid transmission, now found in many places in industry. If a combustion turbine is employed, a combination of turbine speed control and fluid transmission may also be used. Speeds of centrifugal compressors now in use run up to 6000 to 10,000 rpm but need not be so limited. Centrifugal compressors are designed to have a peripheral speed of approximately 750 feet a second.

Much interest has been developed in

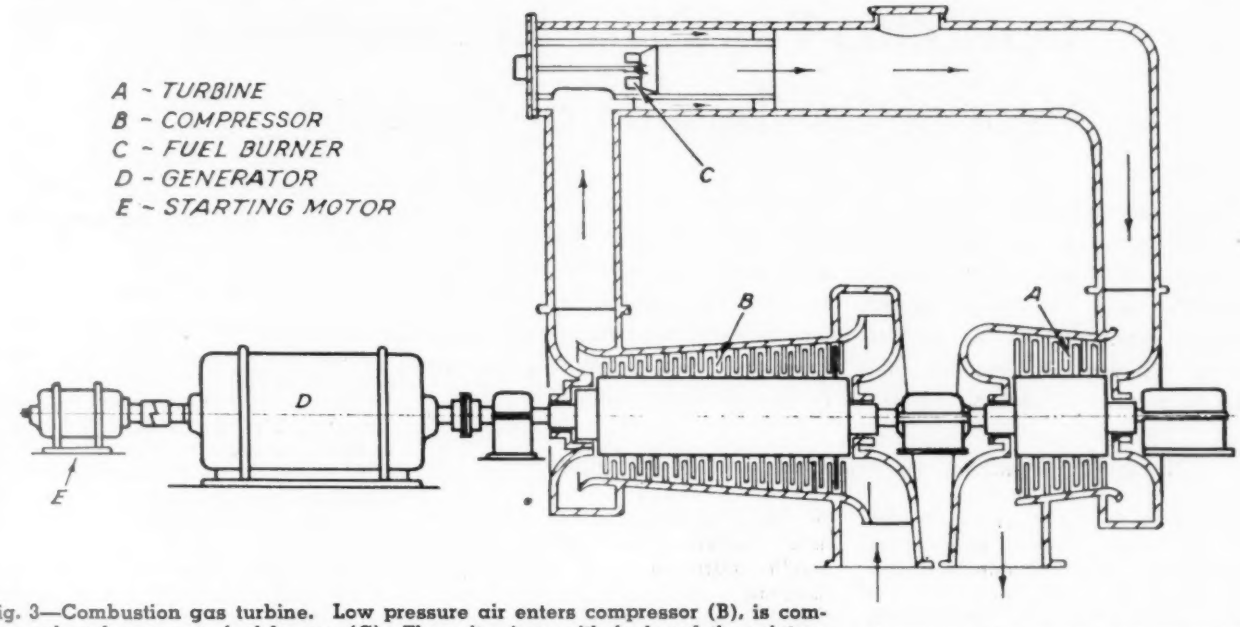


Fig. 3—Combustion gas turbine. Low pressure air enters compressor (B), is compressed and passes to fuel burner (C). There it mixes with fuel and the mixture is ignited, the hot gases passing through and actuating the turbine (A). Excess power not required for operating the compressor may be used to turn over generator (D). Auxiliary starting motor (E) is required to get unit under way

the possible use of combustion turbines (Fig. 3) in place of steam turbines in the natural gas and gasoline industry. The development of this type of prime mover has been very rapid, and its general appearance in both stationary and mobile units is predicted after the war is over. (*See NPN, Technical Section, May* 3, 1944, *pp. R*-308-313.)

At the present time the combustion turbine is used to convert hot waste gases of combustion to useful power. It is in operation in some of the modern refinery processes and is converting otherwise lost energy into useful work. Present trends of design have been for large units, but development of the turbo-supercharger for airplane engines indicates that it will be possible to develop and operate small power units.

General mechanical horsepower in the United States started with the reciprocating steam engine, which was followed by the steam turbine, the ordinary gas or gasoline engine, and the diesel engine, This source of power is now being augmented by the gas turbine. It is estimated that the sum total horsepower hours annually produced by all of the above mechanical power units in the United States exceeds 450 billion, which is about 3000 hp-hrs of work annually for each person in the U. S.

The reciprocating steam engine was a complex, inefficient machine requiring a boiler plant. It was largely replaced by a more efficient steam turbine, but the necessity for the boiler plant remained. Next came the gasoline and diesel engines with increased efficiencies and the elimination of the boiler plant, but with the addition of mechanical complexities. Each of the above type units has a definite place in industry and does not need discussion at this time. The efficiencies of the gasoline and diesel prime movers are considerably higher than the older type reciprocating steam engines. Steam locomotive efficiency runs from 8 to 12%. A gas-fired turbine-driven locomotive developed in Switzerland prior to the war showed an overall efficiency of 15 to 18%.

The gas-fired turbine consists of a power turbine element and an axial type blower on the same shaft. The blower compresses a large volume of low pressure air which is supplied to the burner. Fuel in proper proportion is mixed with the air and ignited, and the hot gas mixture of combustion passes through and actuates the power turbine. The excess power over and above that required for compression of air for combustion is the power available for useful work. The efficiency of the gas-fired turbine is governed by the temperature of the gaseous mixture reaching its rotating elements. A turbine having an efficiency of 18% with combustion gases at 1000°F. will attain an efficiency of 23% when the inlet temperature is raised to 1200°F. With new metals now being developed it is anticipated that operating temperatures may go as high as 1500°F. with corresponding increases in efficiencies.

Gas Turbine Not New

Recent attention to progress of the gas turbine may make it appear that this method of developing power from direct fired gases is a new invention. Patents were issued on this type power unit during the latter part of the 18th century, and at that date it is obvious that engineers of that time recognized the advantages of a single element rotating power unit free of the complexities of a steam plant.

The high stage of development of the steam turbine no doubt had much to do with the parallel development of the gas-fired turbine. Metallurgy of materials probably had more to do with its recent fast growth than any other single factor.

The approximate temperature of the exhaust from a turbine with 1000°F. inlet temperature is a little over 600°F.; by utilizing the exhaust heat to preheat air from the axial compressor to the burner unit the efficiency of the unit may be raised by approximately 50%.

Higher operating temperatures require increasing compression ratios in the compressor unit but also increase the overall thermal efficiency of the unit. The efficiency of the compressor part of the gas turbine unit has much to do with the overall efficiency of the unit. By increasing the efficiency of the compressor unit from .75 to .90, a change of 20%, an overall efficiency of 400% in maximum thermal efficiency is obtainable.

It is not believed that the gas-fired unit will replace the steam actuated type, but it is felt a unit operating free from water supply will have many inherent advantages in gas and gasoline plant operations in certain areas where water is scarce and that which is available is of poor quality. Direct-fired turbines can be fired with any liquid or gaseous fuels and should be well adapted to certain power requirements in gasoline plant operations.

A centrifugal compressor unit driven by a gas-fired turbine will give the simplest mechanical designed unit yet developed and offers the natural gasoline industry the possibility of new features in design at a greatly reduced horsepower cost. Exhaust heat from the turbine, with proper design, could supply much of that required for processing.

Operating Procedure for Determining Heat of Combustion of Gasoline*

This paper describes details of operating procedure for determining the heat of combustion of gasoline, a necessary value in many aviation gasoline specifications. The method usually followed is basically the A.S.T.M. method of test for thermal value of fuel oil, modified for volatile fuel. Most published directions, however, leave out many of the details essential for accurate determinations, details which the authors now supply from their own practical experience in the laboratory.

*By E. W. Dean, A. A. Williams, and N. E. Fisher***

MANY of the specifications for aviation gasoline now in effect in the United States include a minimum limit for lower or net heat of combustion. The prescribed procedure is to determine the gross calorific value in an approved oxygen-bomb calorimeter and obtain the net value by making a suitable correction for the latent heat of vaporization of water formed during combustion of the fuel.

Practically all published directions for determining the gross calorific value of aviation gasoline are exemplified by Method 250.2 of the Federal Specification for Lubricants and Liquid Fuels [2]. This prescribes the use of the standard A.S.T.M. method of test for thermal value of fuel oil [1] modified as follows for volatile fuel:

Fill a dry, weighed, gelatin capsule of suitable size with dry cotton fiber, weigh the capsule again, and record the weight of gelatin and cotton. Fill the capsule by immersing it in the fuel and closing it under the surface. Dry the outside of the capsule, weigh the capsule immediately, and record the weight of the fuel. Wrap the ignition wire around the capsule three or four times and place the capsule immediately in the bomb. Fill the bomb with oxygen at 30 atmospheres pressure, and proceed with the test as outlined in Method 250.1.

Repeat the test if traces of sooty deposit or odor of unburned fuel are noticed when the bomb is opened after combustion.

Corrections. Make all corrections outlined in Method 250.1 and in addition correct for the heat of combustion of the gelatin and the cotton by subtracting from the total heat developed.

These directions, obviously, leave a great deal to the imagination of the operator. The authors' laboratory has had occasion to acquire a large amount of experience with this particular determination, and the present paper discusses the details which are missing in the published directions quoted above, and gives specific instructions followed by their operators.

Condition and Size of Gelatin Capsules

The use of a dry gelatin capsule of suitable size is prescribed. As purchased, capsules contain a large and indeterminate amount of water. One batch dried in a desiccator over calcium chloride showed a loss of weight of about 10% for the first day, and an additional 4.5% in the 20 days following. Complete drying could be effected by heating in an oven at 221° F., but the capsules then became brittle and unusable. It was found that capsules "as received" did not change appreciably during the normal time of the weighing operation, regardless of whether the humidity was high or low, and it appeared that the important feature was to ensure uniform water content in a batch, and to avoid extraneous surface moisture.

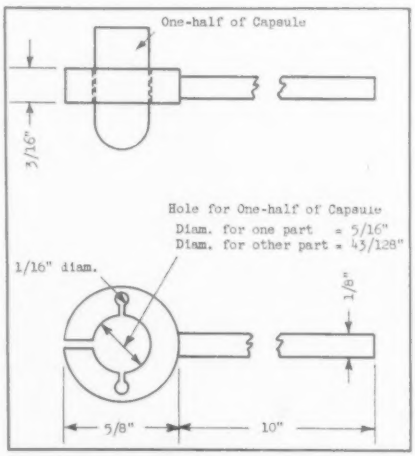


Fig. 1—Capsule holder. Use of a special brass holder such as shown above aids in filling capsules. Holder consists of two parts, one for each half-capsule. Inside diameters given here are suitable for capsules used in authors' laboratory

Capsules having a suitable capacity of about 0.1 ml. are designated as "No. 00 size" by at least one commercial supplier.

Filling of Capsules

The published directions call for filling a weighed capsule containing a determined quantity of dry cotton, by immersing it in the fuel and closing it under the surface of the liquid. The cotton serves to minimize splashing when the capsule is ignited in the bomb. Ignited asbestos serves the same purpose and has the obvious advantage of contributing nothing to the heat generated during the combustion period. However, by observing certain simple precautions it is possible to dispense with cotton or asbestos. Splashing does not occur if the capsules are completely filled with liquid and free from even the smallest bubble of air or other permanent gas.

The prescribed operation of filling by pushing together the two halves of the capsule below the surface of the liquid fuel can, if necessary, be performed with the fingers. The use of a special brass holder, such as is shown in Figure 1, has obvious advantages, particularly as regards the size of the container and the quantity of fuel required. It is not considered good practice to fill more than one capsule from the portion of gasoline which has been poured into the dish.

Evaporation Losses

The fact that capsules are not perfectly tight is recognized in the published directions, by the provision for weighing "immediately" after filling, and placing the capsule in the bomb "immediately" after adjusting the ignition wire. This is to minimize evaporation losses which change the composition of the fuel and introduce an uncertainty as to the weight of the charge actually burned in the bomb. The error due to change in composition of the gasoline seems to be unavoidable but is of negligible magnitude when dealing with the present types of aviation fuel and is perhaps 0.02 or 0.03% for each full per cent evaporation loss. The error due to loss of material is in direct proportion to the amount of gasoline that is vaporized.

A simple practical scheme, devised for determining the evaporation loss between the time of completing the final weighing of the filled capsule and the time of closing the bomb, involves determining the rate of evaporation loss (rejecting the capsule if this is excessive) and measuring the time interval between the completion of the weighing and the closing of the bomb. When the initial evaporation loss is not in excess of 0.0010 gram per minute, the rate remains prac-

*Reprinted from the Analytical Edition of Industrial and Engineering Chemistry for March 5, 1944.

**All three authors are associated with the Standard Oil Development Co., Standard Inspection Laboratory, Bayonne, N. J.

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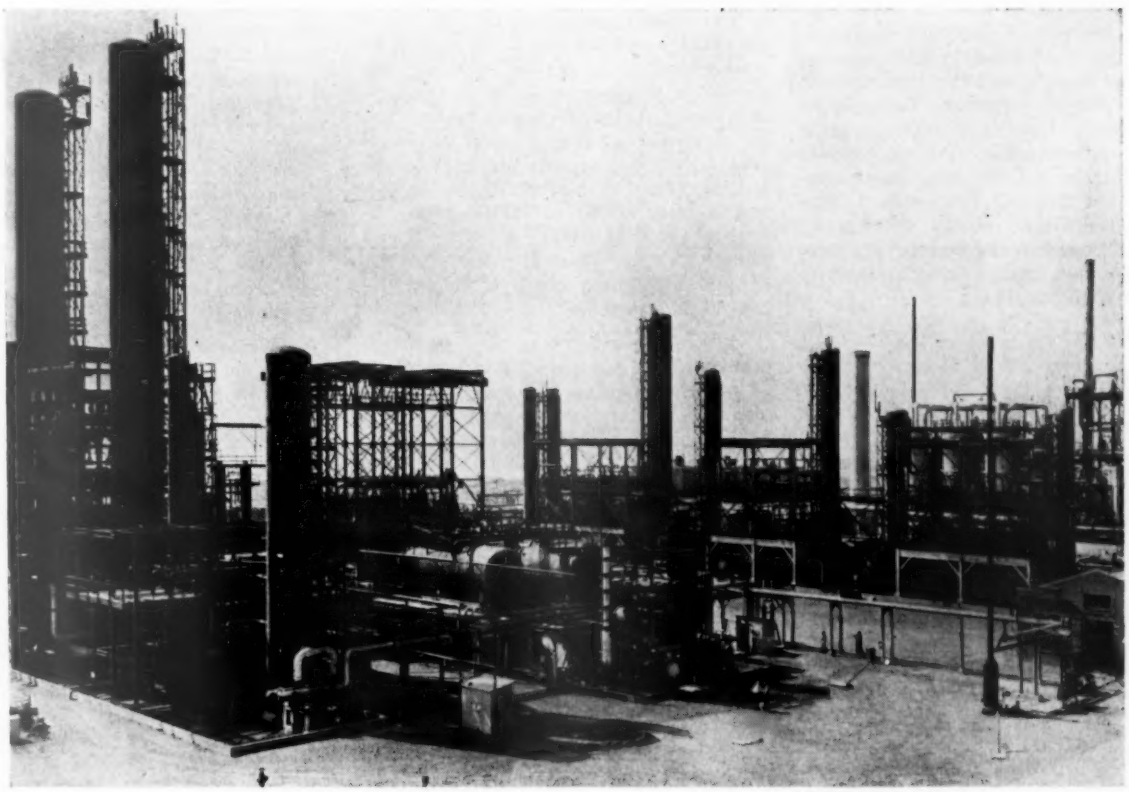

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tically constant for at least 2 additional minutes. An experienced operator can usually transfer a capsule from the pan of the balance to the bomb in one minute or less.

Detailed Working Directions

Preparation of Supply of Capsules. Place approximately 1000 gelatin capsules in a bottle with a tight screw top. Allow to stand for at least 30 days to ensure equalization of the moisture content of all individual capsules. In case of emergency, this "soaking" period may be reduced to one week by using an oversize bottle and shaking its contents vigorously at least twice a day.

At the time the soaking period is started, prepare test portions for determination of the calorific value of the gelatin. Each portion consists of about ten capsules, cut into small pieces and placed inside a capsule. Put these test portions, with the halves of the containing capsules separated, in a small shallow dish or a perforated gill can, which is placed in the bottle with the main supply. At the end of the soaking period, remove the can, assemble the capsules, and place them in a small bottle which is tightly closed. Remove the gelatin-filled capsules from this bottle one at a time for determination of their calorific value. Make at least three determinations, and if the average deviation from the mean of these results exceeds 45 B.t.u. per pound, make additional determinations until the average deviation is less than this amount.

Transfer at least 100 capsules from the large bottle to a set of small screw-top bottles of similar type, putting 10 to 15 capsules (approximately 2 days' supply) in each bottle. Avoid making the transfer under conditions which might cause the capsules to pick up surface moisture. The relative humidity should not be too high and the capsules should not be far enough below room temperature to bring about condensation.

Filling of Capsules. Withdraw a capsule from the current working supply, restoppering the bottle immediately. Weigh with an accuracy of 0.1 mg. and record as W_1. Pour some of the sample to be tested into a small beaker or crucible. Place each half of the capsule in a suitable brass holder such as is shown in Fig. 1. Immerse the halves of the capsule in the gasoline, with the open ends obliquely upward, and agitate very gently for 20 to 30 seconds, to get rid of bubbles of occluded air or other permanent gas which would interfere with complete filling. Then put the two halves together, still keeping them immersed. Withdraw from the liquid, wipe dry with a clean cloth, and place on the pan of the balance.

Weigh to 0.1 mg. and record as W_2. When balance is attained, start a stop watch and obtain another weight exactly 60 seconds later. Record as W_3. Insert the filled capsule in a coil of ignition wire, already attached to the terminals of the bomb and push it down into the cup or crucible. The coil is made by wrapping three or four turns of ignition wire around a rod of the same diameter as the capsules. Care should be taken not to warm the capsule appreciably while transferring from the balance to the coil of ignition wire. If the operator uses bare fingers, they must be dry and his touch must be light. Other precautions, such as the use of special tongs, are obviously permissible. Stop the watch when the lid of the bomb is in place. Do not include the operations of screwing on the lock ring, etc., in the time period thus measured.

Compute the weight of gasoline burned, W_b, from the following formula:

$$W_b = (W_2 - W_1) - (W_2 - W_3)\ \frac{t}{60}$$

t is the time in seconds elapsed between completion of the first weighing of the filled capsule and the closing of the bomb, specifically, it is the stop-watch reading. $(W_2 - W_1)$ is the weight of gasoline originally in the capsule and $(W_2 - W_3)$ the amount lost by evaporation during the 60-second period the filled capsule was kept on the balance pan. A normal figure for this loss is from 0.0001 to 0.0010 gram. If it is as much as 0.0015 gram, or if any bubble of air or vapor is observed in the capsule before the bomb is closed, the capsule is rejected.

Obtaining a weight at some predetermined instant is easy with various types of automatic-reading balances now available. If the simple conventional type of balance is used it is recommended that its sensitivity be determined and that $(W_2 - W_3)$ be measured in terms of change in the swing rather than by trying to shift the rider. It is, however, possible to measure the time for, say, 0.0010-gram loss rather than the loss during 60 seconds. If this is done, the formula above should be suitably modified.

Other Methods

A somewhat different procedure, using gelatin capsules, has been described by Jones and Starr [4]. It has not been tried in the authors' laboratory but they believe it is slightly less convenient and no more accurate than that described above.

The method of Richter and Jaeschke [7] involves weighing the charge of gasoline in a special platinum crucible covered with a thin skin of collodion. It has not been tried, but the accuracy claimed is no better than that normally attained with the procedure described above.

The most precise method known to the authors is that originally described by Richards and Barry [6], and later improved by Jessup [3] and Prosen and Rossini [5]. The charge is weighed in a hermetically sealed special glass bulb with flattened sides. This bulb, if properly made and completely filled, opens in the bomb without splashing, when exposed to the heat generated by the combustion of the iron fuse wire. The procedure is more time-consuming than that described above and the technique of fabricating, filling, and sealing the bulbs requires a higher degree of manipulative skill than is necessary when using gelatin capsules.

The authors take this opportunity to suggest that the ideal solution of the problem is to weigh the charge in a special closed container which opens mechanically in the bomb when the ignition wire is burned. With adequate ingenuity and experimentation a practical device of this type might be developed.

Precision Attainable

It is customary in the authors' laboratory to make a blank determination once a day on a sample of "chemically pure" benzene. Table I shows the results obtained in a period, selected at random, of 29 consecutive working days.

The exact calorific value of the benzene used is not known, hence these "blank" determinations are an index of the reproducibility rather than the absolute accuracy of the determinations. The basic standard is benzoic acid, obtained from and certified by the National Bureau of Standards.

TABLE I

(Benzene Blank Determination for a Typical Period of 29 Consecutive Working Days)

(Values in British thermal units per pound)

18,032	18,020	18,005	18,071
18,030	18,031	18,057	18,057
18,011	18,069	18,043	18,039
18,032	18,065	18,048	18,045
18,048	18,034	18,067	18,030
18,041	18,057	18,045	18,033
18,042	18,005	18,060	18,058
18,010			

Mean, 18,041.

Av. deviation from mean, 15.5 B.t.u., or 0.086%.

Max. deviation from mean, 36 B.t.u., or 0.200%.

Literature Cited

(1) Am. Soc. Testing Materials, Standard Method D240-39.

(2) Federal Specification for Lubricants and Liquid Fuels, VV-L-791b Method 250.2, p. 102 (Feb. 19, 1942).

(3) Jessup, R. S., *J. Research Natl. Bur. Standards*, XVIII, 115-28 (1937).

(4) Jones, W. H., and Starr, C. E., Jr., *Ind. Eng. Chem.*, Anal. Ed., XIII, 287-90 (1941).

(5) Prosen, E. J. R., and Rossini, F. D., *J. Research Natl. Bur. Standards*, XXVII, 289-310 (1941).

(6) Richards, T. W., and Barry, Frederick, *J. Am. Chem. Soc.*, XXXVII, 993-1020 (1915).

(7) Richter, M., and Jaeschke, Marg., *Angew. Chem.*, LI, 146-7 (1938).

Method For Recovery of Sulfur from Sulfur Dioxide in Waste Gases*

Removal of sulfur dioxide from waste gases produced in refineries can be accomplished by a catalytic process operating at atmospheric pressure. Even wet gases containing relatively low percentages of sulfur dioxide can be treated.

The recovery process, as explained in the following article describing the experimental work, involves two steps. In the first step, the sulfur dioxide-containing gas is mixed with hydrogen and passed through a catalyst bed at temperatures above 300°C., resulting in a mixture of hydrogen sulfide and sulfur dioxide. In the second step complete conversion to elemental sulfur is accomplished by passing the mixture of hydrogen sulfide and sulfur dioxide from step one over activated alumina at temperatures of 100° to 200°C.

The resulting free sulfur tends to deposit in the catalyst bed, deactivating the alumina catalyst. Reactivation can be accomplished by raising the temperature of the catalyst and vaporizing the sulfur.

*By T. F. Doumani, R. F. Deery, and W. E. Bradley***

THE WASTE gases from certain types of operation, such as the processing of sulfur-containing crude oils, contain appreciable percentages of sulfur dioxide. Owing to the nuisance and consequent possibility of litigation arising from the indiscriminate venting of such gases to the atmosphere, a number of industries have devised methods for recovering the sulfur dioxide. Normally, the process selected is dependent on the composition of the gas to be treated, particularly its sulfur dioxide and water content.

The methods previously reported for the reclaiming of elemental sulfur from sulfur dioxide-containing gases involve either concentration of the sulfur dioxide and subsequent reduction, or direct conversion to sulfur. The following materials have purportedly been used for the conversion steps: (a) coke, (b) carbon monoxide, (c) hydrocarbons, (d) hydrogen sulfide, and (e) hydrogen.

Essentially, the commercial processes employing metallurgical coke[2] comprise passing the sulfur dioxide with pure oxygen through an incandescent coke bed and producing carbon dioxide, sulfur vapor, carbon monoxide, and carbon oxysulfide. The latter compound, formed by the apparently rapid reaction of sulfur vapor with carbon monoxide, is catalytically reacted with additional sulfur dioxide to form elemental sulfur. The gas containing sulfur vapor is partially cooled and the sulfur collected by means of Cottrell precipitators. Another commercial process comprises passing gases containing 0.5 to 3.0% sulfur dioxide through a coke bed at a temperature above 900°C. The exit gases from the coke bed, containing carbon oxysulfide, carbon disulfide, and unreacted sulfur dioxide, are then passed over bauxite maintained at 400 to 700°C. as described by Roesner[6]. The thermodynamics and kinetics of the reduction of sulfur dioxide with coke have been reported by Lepsoe[5]. Petroleum coke would be expected to act similarly. However, the presence of volatile hydrocarbons makes possible the reduction at lower temperatures. Hydrogen sulfide is also produced. Apparently the reaction proceeds at the expense of the hydrocarbons, for the graphitic carbon remains practically intact.

Carbon monoxide is used commercially for the direct treatment of dry smelter gases of about 8% sulfur dioxide content, according to Appleby[1]. Essentially, the process comprises the production of carbon monoxide, catalytic reduction of the sulfur dioxide-containing gases by the carbon monoxide, and finally the cooling of the gases and separation of the sulfur by electrostatic precipitation. Coke is used as the source material for the carbon monoxide, and the latter is reacted with sulfur dioxide at 250 to 300°C. in catalyst chambers containing mixed ferric and aluminum oxides.

The use of hydrocarbons for the reduction of sulfur dioxide has been studied by Yushkevitch and co-workers[10]. It was found that methane and sulfur dioxide react at 900°C. in the presence of bauxite to form sulfur, hydrogen sulfide, water, and carbon dioxide, with a yield of sulfur, based on the methane consumed, of 89 to 95%. At higher temperatures hydrogen and carbon monoxide are also formed, and at lower temperatures the methane reacts incompletely. Light hydrocarbons (benzene) react with sulfur dioxide at 700 to 800°C. to give 60 to 90% yields of sulfur.

Some work has been reported on the reduction of sulfur dioxide with hydrogen when employing dry gases[9]. At 500 to 800°C. hydrogen was reacted almost completely with sulfur dioxide over various catalysts, principally bauxites, forming sulfur in 40 to 60% yields; the remaining sulfur formed hydrogen sulfide.

A commercial process for the reduction of sulfur dioxide with hydrogen sulfide operates at 232°C. using a catalyst whose composition is not given[4]. Sulfur is also produced by passing sulfur dioxide gases into hydrosulfurous acid solutions, as described by Leahy[3].

The experimental work reported in this paper deals with the reduction of sulfur dioxide with hydrogen and the interaction of sulfur dioxide and hydrogen sulfide to form free sulfur. Both wet and dry gases were used.

Chemical and thermodynamic equations for the reduction of sulfur dioxide

TABLE I—Chemical and Thermodynamic Equations*

(1) $2SO_2\ (g)+4H_2\ (g)\rightleftarrows S_2\ (g)+4H_2O\ (g)$
$\Delta F^\circ = -63{,}120-1.74T\ \ln T+(1.22)(10^{-2})T^2-(2.1)(10^{-6})T^3+13.9T$
$\log K=13{,}800/T+0.88\ \log T-(2.65)(10^{-3})T+(4.6)(10^{-7})T^2-3.04$

(2) $2SO_2\ (g)+4H_2\ (g)\rightleftarrows 1/3\ S_6\ (g)+4H_2O\ (g)$
$\Delta F^\circ = -86{,}170-3.48\ T\ \ln T+(8.0)(10^{-3})T^2-(2.1)(10^{-6})T^3+54.3T$
$\log K=18{,}830/T+1.75\ \log T+(1.75)(10^{-3})T+(4.60)(10^{-7})T^2+10.88$

(3) $2SO_2\ (g)+4H_2\ (g)\rightleftarrows \tfrac{1}{4}S_8\ (g)+4H_2O\ (g)$
$\Delta F^\circ = -88{,}700-3.48T\ \ln T+(8.0)(10^{-3})T^2-(2.1)(10^{-6})T^3+57.9T$
$\log K+19{,}400/T+1.75\ \log T-(1.75)(10^{-3})T+(4.60)(10^{-7})T^2-12.68$

(4) $2H_2\ (g)+S_2\ (g)\rightleftarrows 2H_2S\ (g)$
$\Delta F^\circ = -38{,}400+1.88T\ \ln T+(3.30)(10^{-3})T^2-(7.4)(10^{-7})T^3+3.3T$
$\log K=8{,}400/T-9.5\ \log T-(7.2)(10^{-4})T+(1.62)(10^{-7})T^2-0.72$

(5) $SO_2\ (g)+2H_2S\ (g)\rightleftarrows 2H_2O\ (g)+3/2S_2\ (g)$
$\Delta F^\circ = 6{,}870-2.75T\ \ln T+(2.8)(10^{-3})T^2-(3.1)(10^{-7})T^3+3.4T$
$\log K=-1{,}503/T+1.38\ \log T-(6.13)(10^{-4})T+(6.78)(10^{-8})T^2-0.74$

(6) $SO_2\ (g)+2H_2S\ (g)\rightleftarrows 2H_2O\ (g)+\tfrac{1}{2}S_8\ (g)$
$\Delta F^\circ = -27{,}730-5.36T\ \ln T-(3.5)(10^{-3})T^2-(3.1)(10^{-7})T^3+64.2T$
$\log K=6{,}070/T+2.70\ \log T+(7.67)(10^{-4})T+(6.78)(10^{-8})T^2-14.04$

(7) $SO_2\ (g)+2H_2S\ (g)\rightleftarrows 2H_2O\ (g)+\tfrac{3}{8}S_8\ (g)$
$\Delta F^\circ = -31{,}530-5.36T\ \ln T-(3.5)(10^{-3})T^2-(3.1)(10^{-7})T^3+69.5T$
$\log K=6{,}880/T+2.69\ \log T+(7.66)(10^{-4})T+(6.78)(10^{-8})T^2-15.2$

(8) $SO_2\ (g)+3H_2\ (g)\rightleftarrows H_2S\ (g)+2H_2O\ (g)$
$\Delta F^\circ = -50{,}760+0.07T\ \ln T+(7.75)(10^{-3})T^2-(1.42)(10^{-6})T^3+9.35T$
$\log K=11{,}100/T-0.035\ \log T-(1.69)(10^{-3})T+(3.1)(10^{-7})T^2-2.04$

* Free energies of formation from International Critical Tables, Vol. 7, p. 236 (1930)

*Presented before the Petroleum Section of the American Chemical Society, at Pittsburgh, Sept., 1943.

**All three authors are associated with the Union Oil Co. of California, Wilmington, Calif.

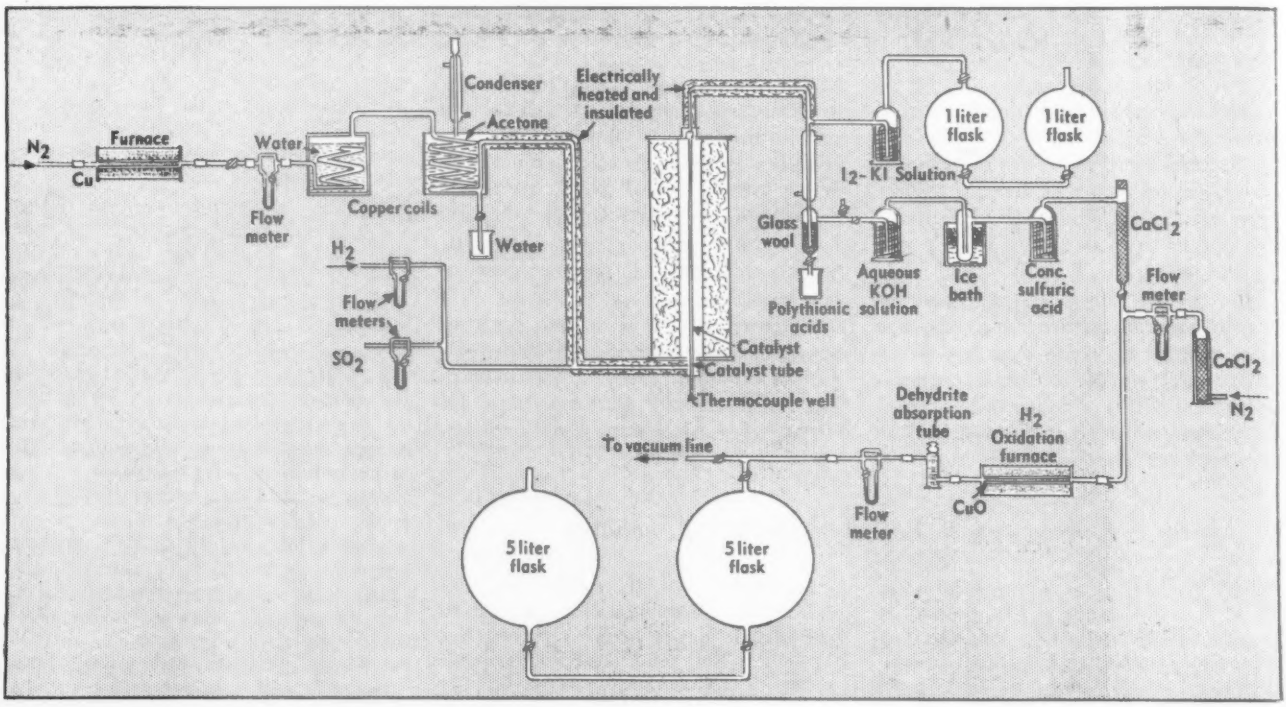

Fig. 1—Apparatus employed for the reduction of sulfur dioxide with hydrogen. For the reaction of sulfur dioxide with hydrogen sulfide, the apparatus was modified and somewhat simplified: equipment for the determination of hydrogen was eliminated, and the hydrogen sulfide was admitted into the catalyst tube 0.25 in. below the catalyst bed through four small holes in the thermocouple wall

with hydrogen and hydrogen sulfide are given in Table I. Due to the variable composition of sulfur vapor with temperature and concentration, and the difficulty of determining the amounts of each form present, the equations are given for the various possible sulfur forms. Over the temperature range of 150 to 500°C., diatomic sulfur seems to be less involved in the various chemical equilibria than are S_6 and S_8. Free energies and equilibribium constants for the chemical equations that might be involved are given in Table II.

Equilibrium constants for the various above-postulated equations were calculated from available free energy data by means of the equation:

$$\Delta F^\circ = -2.303\ RT \log K$$

Apparatus and Materials

The apparatus employed for the reduction of sulfur dioxide with hydrogen is diagrammatically shown in Fig. 1. Synthetic sulfur dioxide gases were prepared with nitrogen as a diluent. The oxygen in the commercial nitrogen was removed by reaction with finely divided copper which was held at a dull red heat by means of a small tube furnace. In studying the effect of water, the content of the latter was controlled by saturating the metered nitrogen with water vapor by passage through 10 feet of ⅝-in. diameter copper coil containing water held at a predetermined temperature. This nitrogen was then freed of entrained water by passage through another copper coil held at the boiling point of acetone, a stopcock at the bottom of the coil being employed to remove any liquid water condensed from the nitrogen. The nitrogen, hydrogen, and sulfur dioxide were then introduced through an electrically heated section of stainless steel pipe into the reaction furnace containing the catalyst. The exit end of the catalyst tube was electrically heated to prevent condensation of sulfur therein. The condensation of sulfur took place almost quantitatively in a removable two-inch section of glass tubing, the remaining sulfur being collected in the glass wool. The rest of the apparatus pictured in Fig. 1 was used to determine the hydrogen sulfide, sulfur dioxide, and hydrogen in the exit gases.

The apparatus employed for the re-

TABLE II—Free Energies and Equilibrium Constants

Temp., °C.	Equation 1		Equation 2		Equation 3		Equation 4	
	ΔF°	K	ΔF°	K	ΔF°	K	ΔF°	K
150	—59,700	6.8×10^{30}	—70,800	4×10^{36}	—71,800	1.3×10^{37}	—31,600	2.2×10^{16}
200	—59,100	2.2×10^{27}	—69,030	8×10^{31}	—69,900	2×10^{32}	—30,700	1.6×10^{14}
250	—58,500	3.2×10^{24}	—67,270	1.3×10^{28}	—67,900	3×10^{28}	—29,700	2.6×10^{12}
300	—57,900	1.3×10^{22}	—65,480	1.0×10^{25}	—65,900	1.4×10^{25}	—28,700	8.5×10^{10}
350	—57,200	1.1×10^{20}	—62,700	1.0×10^{22}	—63,900	3×10^{22}	—27,700	5.4×10^{9}
400	—56,500	2.3×10^{18}	—61,810	1.2×10^{20}	—61,900	1.3×10^{20}	—26,600	4.6×10^{8}
450	—55,800	7.6×10^{16}	—60,020	1.4×10^{18}	—60,000	1.4×10^{18}	—25,600	5.6×10^{7}
500	—55,000	3.5×10^{15}	—57,400	1.7×10^{16}	—58,000	2.5×10^{16}	—24,600	9.3×10^{6}

Temp., °C.	Equation 5		Equation 6		Equation 7		Equation 8	
	ΔF°	K	ΔF°	K	ΔF°	K	ΔF°	K
150	1,740	—8.0	—15,000	5.6×10^{7}	—16,500	3.4×10^{8}	—45,340	3.6×10^{25}
200	1,060	—3.2	—13,850	2.3×10^{6}	—15,150	5.0×10^{7}	—44,550	4.0×10^{20}
250	370	—1.4	—12,760	2.0×10^{5}	—13,760	3.8×10^{5}	—43,730	1.9×10^{18}
300	—320	1.3	—11,640	3.0×10^{4}	—12,440	5.8×10^{4}	—42,880	2.2×10^{16}
350	—1,040	2.3	—10,660	5.8×10^{3}	—11,160	8.3×10^{3}	—41,970	5.5×10^{14}
400	—1,720	3.7	— 9,710	1.5×10^{3}	— 9,910	1.7×10^{3}	—41,080	2.2×10^{13}
450	—2,430	5.5	— 8,880	4.8×10^{2}	— 8,680	4.2×10^{2}	—40,140	1.4×10^{12}
500	—3,080	7.8	— 7,760	1.8×10^{2}	— 7,560	1.4×10^{2}	—39,100	1.3×10^{11}

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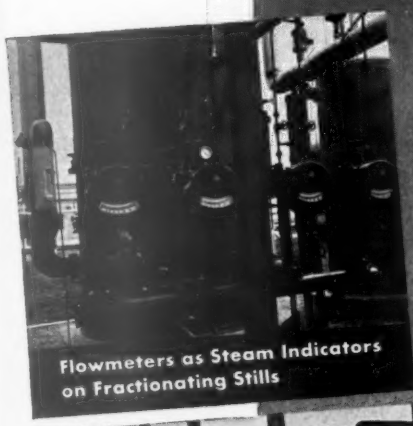

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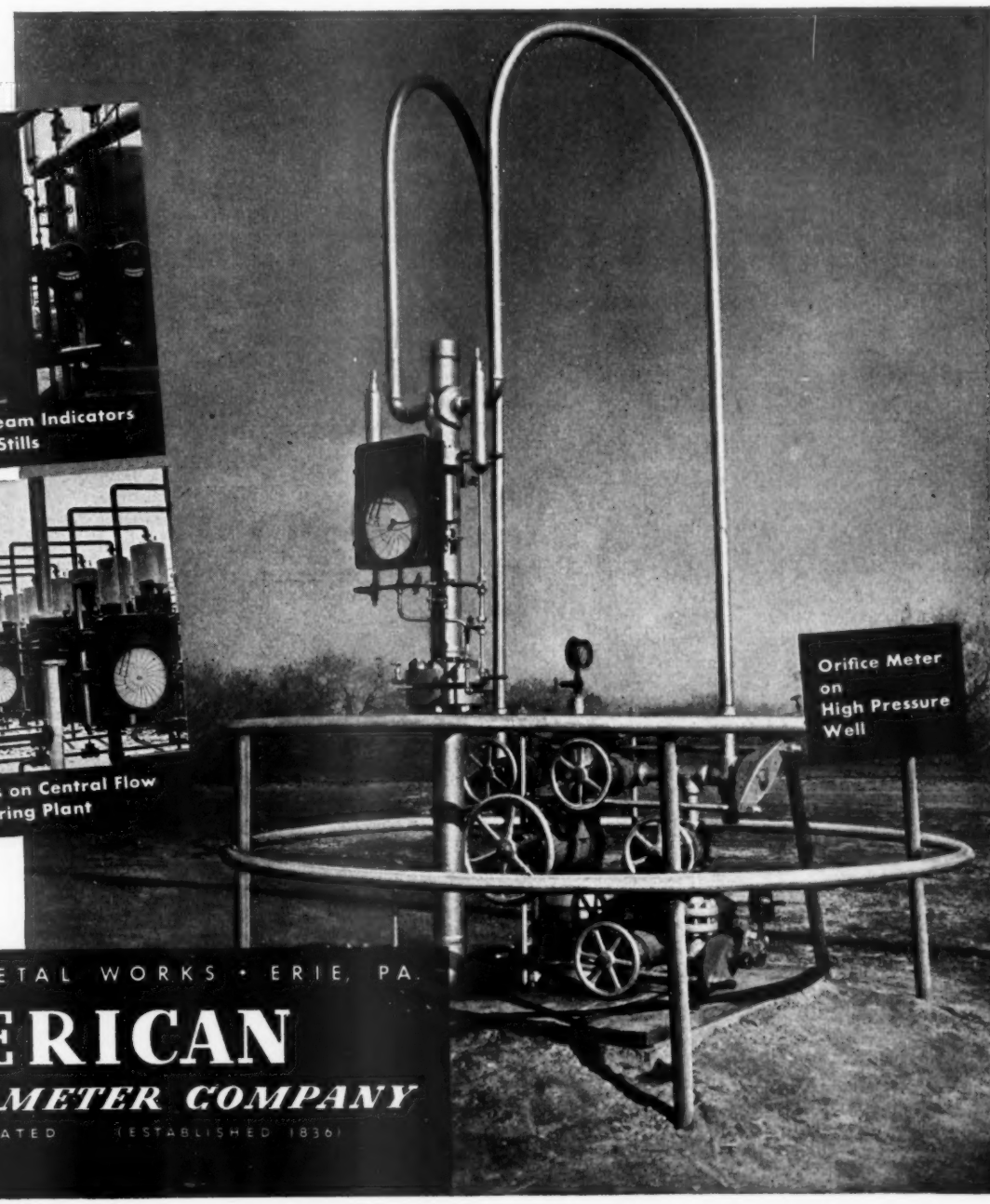

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action of sulfur dioxide with hydrogen sulfide was simpler than for the reduction of sulfur dioxide with hydrogen. Equipment for the determination of hydrogen was eliminated (Fig. 1) and the following modification was used. Hydrogen sulfide was admitted into the catalyst tube 0.25 in. below the catalyst bed through four small holes in the thermocouple well. This was found to be necessary to avoid reaction of the hydrogen sulfide with the sulfur dioxide before the mixture reached the catalyst. This thermal reaction is much slower than the desired catalytic one.

The compressed gases used were obtained from the following sources: hydrogen sulfide—Ohio Chemical and Manufacturing Co.; refrigeration grade sulfur dioxide—Dow Chemical Co., and the nitrogen and hydrogen—Linde Air Products Co.

Method of Analysis

Analyses for sulfur dioxide and hydrogen sulfide were usually made simultaneously. A definite volume of the gas containing hydrogen sulfide, sulfur dioxide, hydrogen, and inert gases was bubbled through a definite volume of standard iodine solution and the excess iodine titrated with standard sodium thiosulfate solution. After subtracting a blank correction (obtained by bubbling into an equal volume of the standard iodine solution a volume of air equal to the volume of inert gases in the sample taken for analysis), the equivalents of hydrogen sulfide plus sulfur dioxide could be determined. Since there is twice as much acid formed when sulfur dioxide is titrated with iodine as when hydrogen sulfide is titrated, the amount of each can be calculated from the two simultaneous equations, one involving the equivalents of iodine consumed and the other the equivalents of acid formed (titrated with standard sodium hydroxide solution). The equations involved are as follows:

$$H_2S + I_2 \rightarrow S + 2HI$$
$$SO_2 + I_2 + 2H_2O \rightarrow H_2SO_4 + 2HI$$

Analyses for hydrogen were executed by oxidation of a definite volume of the feed and product to water by means of copper oxide which was maintained at a dull-red heat. Both the hydrogen sulfide and sulfur dioxide were first removed by means of an alkaline wash solution, followed by partial dehydration of the sample by cooling to 0°C., followed by further drying with concentrated sulfuric acid, and finally with calcium chloride. The amount of H_2O formed was determined gravimetrically by absorption in tubes containing magnesium perchlorate.

When the amount of hydrogen sulfide was low in comparison with the amount of sulfur dioxide, it was determined directly by titration with standard iodine solution after converting the sulfur dioxide to a sulfurous addition compound with formaldehyde in aqueous zinc acetate solution, according to the improved method of Wollak[8].

Reduction With Hydrogen

The reduction of sulfur dioxide with hydrogen was first carried out with a bauxite which analyzed as follows:

Alumina, Al_2O_3	78.6%
Iron Oxide Fe_2O_3	8.8
Titanium Dioxide, TiO_2	4.0
Insoluble Matter	6.7
Loss on Ignition	1.9
	100.0%

Below 325°C., the reduction of SO_2 (2.5%) with hydrogen (5.0%) in the presence of nitrogen (92.5%) was not detectable. At 370°C., the reduction proceeded slowly, and at 425 to 480°C. quite rapidly. Furthermore, it was found that the catalyst improved considerably after several hours usage as evidenced by the increased conversions with time, and the fact that the used catalyst was effective for certain space velocities and temperatures at which the fresh catalyst affected no detectable conversion. Inspection of the used catalyst showed that a portion at the exit end of the catalyst tube had darkened considerably owing to the formation of iron sulfide, which was proved by analysis. A negative sulfide test was obtained with a portion of the catalyst at the entrance end of the catalyst.

The observation that it is the sulfide of the metal which is the catalyst and not the oxide is of practical value, for regeneration of the sulfide catalyst is not necessary; whereas, if the metal oxides were catalysts, regeneration would be necessary because of the transformation of the oxide to the sulfide.

This formation of iron sulfide from the iron oxide of the catalyst explains why at first the iron oxide catalysts show no activity and gradually increase with passage of the gas at temperatures of about 325°C. This initial period of no activity at these low temperatures occurs when there is no iron sulfide present, and the period of slowly increasing activity represents the time when the iron oxide is being transformed to iron sulfide. This same effect was noticed with all the iron oxide-containing catalysts tried. To convert the iron oxide in the catalysts to the sulfide, prior to their use for the reduction, they were pretreated with hydrogen sulfide at about 500°C.

The reaction between ferric oxide and hydrogen sulfide has been studied by Sayce[7]. At 300°C., iron disulfide, FeS_2, is obtained exclusively as the product; whereas, between 400 and 500°C., a product is obtained which is soluble in hydrochloric acid with liberation of sulfur. This material was regarded as a mixture of FeS and FeS_2, although it is believed that it might be Fe_3S_4.

Catalysts for Reduction With Hydrogen

Various metal oxides and salts were tried as catalysts; however, those containing iron sulfide were found to be the most economical and effective. Gel catalysts consisting of ferric and aluminum oxides and pre-treated with hydrogen sulfide to convert the iron oxide to the sulfide are particularly valuable for the reduction of sulfur dioxide with hydrogen. These catalysts may be used at temperatures as low as 325°C. at atmospheric pressure, with space velocities of over 600 volumes of gas per volume of catalyst per hour (Table III-B). Both wet and dry gases containing low percentages of sulfur dioxide can be catalytically treated, so that all of the sulfur dioxide is reduced to hydrogen sulfide and free sulfur, or the amount of hydro-

TABLE III

REDUCTION OF SULFUR DIOXIDE WITH HYDROGEN

A. With bauxite catalyst, 12-20 standard Tyler mesh.
Reaction Temperature—482°C. (900°F.)
Pressure—atmospheric.

	Gaseous Feed[1] Mol. %	Gaseous Product[4], Using Dry Feed[2] Mol. %	Gaseous Product[4], Using Wet Feed[3] Mol. %
SO_2	3.10	1.10	1.41
H_2	4.87	0.16	0.42
H_2S	0.000	0.65	1.05
N_2	91.95	98.09	97.12
	100.00	100.00	100.00
SO_2	2.80	0.00	0.24
H_2	9.35	0.25	0.56
H_2S	0.00	2.37	2.56
N_2	87.85	97.38	96.64
	100.00	100.00	100.00

B. With Fe_2O_3 (25%), Al_2O_3 (75%) gel catalyst, 12-20 standard Tyler mesh pretreated with H_2S at 315°C.
Reaction Temperature—315°C. (600°F.)
Pressure—atmospheric.

	Gaseous Feed[1] Mol. %	Gaseous Product[4], Using Wet Feed[3] Mol. %
SO_2	3.0	0.2
H_2	9.3	0.07
H_2S	0.0	2.4
N_2	87.0	97.33
	100.00	100.00
Reaction Temperature—482°C. (900°F.)		
SO_2	3.1	0.7
H_2	7.1	0.1
H_2S	0.0	1.3
N_2	89.8	97.9
	100.0	100.0

(1) Space Velocity—592 volumes of dry feed per unit volume of catalyst per hour at standard conditions.
(2) Product when the feed contained no water vapor.
(3) Product when the feed contained 13.3% water vapor.
(4) Product also contained some free sulfur and some polythionic acids in the aqueous condensate.

gen can be regulated so that the exit gas contains the required amount of hydrogen sulfide for its stoichiometrical interaction with sulfur dioxide to form free sulfur (discussed later).

At temperatures above 325°C., less active catalysts than the iron-alumina gel types can be used, such as iron sulfide on various aluminas. Bauxites of high iron content are quite effective after converting the latter to the sulfide (Table III-A).

Catalysts for Reduction With H_2S

Many types of catalysts were used for the reduction of sulfur dioxide with hydrogen sulfide. It was found that the aluminum oxide-containing ones were superior to all others tried, being effective even with wet gases. Bauxite (Table IV-A) and precipitated alumina were used at temperatures from 100 to 200°C., but these catalysts were not as good as highly purified and specially treated aluminas, such as "Alorco—Grade A" (Table IV-B). For all these catalysts complete conversion was obtained below about 210°C. at atmospheric pressure.

The activity of these catalysts decreases with the reaction time due to the deposition of sulfur on them. For example, a gaseous mixture consisting of hydrogen sulfide (1.50%), sulfur dioxide (0.75%), water vapor (16.8%) and nitrogen (80.95%) was passed through Alorco—Grade A, 12 to 20 standard Tyler mesh at the rate of 650 volumes of gas per volume of catalyst per hour at 150°C. The exit gases analyzed 0.02 to 0.04% of sulfur dioxide and hydrogen sulfide, respectively, for the first 30 hours, after which the reaction was quite incomplete. Inspection of the catalyst at the end of this time showed that about 90% of the catalyst was covered with sulfur, the bottom portion of the alumina being more densely covered than the upper part.

The following method was effective in regenerating the catalysts from deposited sulfur. The reaction tube with the spent catalyst was raised in temperature to 500°C., and held at this temperature for about 2 hours. By this means the sulfur was vaporized from the catalyst and collected as molten sulfur. The last traces of sulfur can be stripped from the catalyst by means of an inert gas.

Discussion

In this work, the sulfur dioxide, hydrogen sulfide, and water vapor contents of the gases reported have been of the approximate composition of certain catalytic regeneration gases from the treatment of high sulfur hydrocarbon feed stocks. The gases employed were sufficiently dilute so that the reaction conditions and catalysts reported should be effective for the reduction of other sulfur dioxide gases.

To recover free sulfur from a sulfur dioxide-containing gas when there is no hydrogen sulfide present, or insufficient for reduction, a two-step process can be used. The reactions involved may be represented by the following equations:

$$2SO_2+4H_2 \rightleftarrows S_2+4H_2O \quad \ldots\ (1)$$
$$2H_2+S_2 \rightleftarrows 2H_2S \quad \ldots\ (2)$$
$$3/2S_2+2H_2O \rightleftarrows 2H_2S+SO_2 \quad \ldots\ (3)$$
$$2H_2S+SO_2 \rightleftarrows 3S+2H_2O \quad \ldots\ (4)$$

Step 1 (Equations 1, 2, 3) involves reducing all the sulfur dioxide to hydrogen sulfide with hydrogen at a temperature of 315°C. (600°F.) or higher, using an iron sulfide-containing catalyst; or reducing sufficient sulfur dioxide in the gas so that the stoichiometrical quantity of hydrogen sulfide is formed for reduction of the sulfur dioxide (see Table III-B at 482°C.) Step 2 (Equation 4) involves passing a gaseous mixture of hydrogen sulfide and sulfur dioxide in the molar ratio of 2 to 1 over activated alumina at temperatures below about 200°C. (Table IV). The sulfur tends to deposit in the catalyst bed and eventually deactivates the catalyst. Reactivation of the latter is readily accomplished by raising the temperature of the catalyst bed above 500°C.

It was found impossible to reduce sulfur dioxide with hydrogen directly to sulfur without simultaneous formation of hydrogen sulfide. When sulfur dioxide is reacted with sufficient hydrogen to form sulfur (Equation 1) a mixture of sulfur dioxide, hydrogen sulfide (Equation 2) and sulfur is obtained. Furthermore, when reducing wet gases the interaction of sulfur with the water vapor originally present, plus that produced in the reduction, causes the formation of hydrogen sulfide and sulfur dioxide (Equation 3). This is of no serious consequence in the two-step process since these two compounds are formed in the molar proportions required for the second step (Equation 4).

Any oxygen associated with the sulfur dioxide gas should be avoided as much as possible, since it reacts with the iron sulfide in the catalysts converting it to the oxide. If the amount of oxygen is small, the hydrogen sulfide formed in the reduction will convert the iron oxide to the sulfide; however, this is at the expense of a corresponding greater amount of hydrogen.

When reducing sulfur dioxide gases which contain relatively large amounts of water vapor by means of coke, the consumption of the latter substance can become very large due to the reaction of water vapor with the coke.

Conclusions

1. Elementary sulfur can be recovered from sulfur dioxide-containing gases having substantial amounts of water vapor by catalytic reduction with hydrogen.

2. Low percentages of sulfur dioxide can be treated at atmospheric pressure by a two-step process which comprises reducing sulfur dioxide with hydrogen over an iron sulfide catalyst. The resulting gaseous mixture is passed over activated alumina to form free sulfur.

3. The sulfur deactivates the activated alumina catalyst due to its deposition therein; however, reactivation can be accomplished by vaporizing the sulfur from the catalyst.

TABLE IV

REDUCTION OF SULFUR DIOXIDE WITH HYDROGEN SULFIDE

A. With bauxite catalyst, 12-20 standard Tyler mesh.

Space Velocity—550 volumes of feed per unit volume of catalyst per hour at standard conditions.

Feed—2.0 per cent H_2S, 1.0 per cent SO_2, 97 per cent N_2 by volume.

Pressure—atmospheric.

Temperature		Gaseous Product	
		H_2S	SO_2
°F.	°C.	Mol. %	
200	93.3	0.02	0.01
300	148.9	0.01	0.02
400	204.4	0.20	0.22
500	260.0	0.58	0.24
600	315.6	0.64	0.36

B. With activated alumina, Alorco, 12-20 standard Tyler mesh.

Space velocity—650 volumes of feed per unit volume of catalyst per hour at standard conditions.

Feed—1.5 per cent H_2S, 0.75 per cent SO_2, 16.8 per cent H_2O, 80.95 per cent N_2 by volume.

Pressure—atmospheric.

Temperature		Gaseous Product	
		H_2S	SO_2
°F.	°C.	Mol. %	
200	93.3	0.00	0.00
300	148.9	0.00	0.00
350	176.7	0.00	0.00
400	204.4	0.00	0.00
450	232.2	0.18	0.09
500	260.0	0.50	0.28
550	287.8	0.68	0.35
600	315.6	0.91	0.43

Literature Cited

(1) Appleby, M. P., J. Soc. Chem. Ind., **56**, 139T (1937).
(2) Kirkpatrick, S. P., Chem. Met. Eng., **45**, No. 9, 483 (1939).
(3) Leahy, M. J., Refiner **15**, 276 (1936).
(4) Lee, J. A., Chem. Met. Eng., **49**, No. 6, 80 (1942).
(5) Lepsoe, R., Ind. Eng. Chem., **30**, 92 (1938); **32**, 910 (1940).
(6) Roesner, G., Chem. Fabrik., **1937**, 101.
(7) Sayce, L. A., J. Chem. Soc., **1929**, 2002.
(8) Wollak, R., Z. anal. Chem., **77**, 401 (1929).
(9) Yushkevitch, N. F., Karzhavin, V. A., Avdeeva, A. V., and Krechemov, T. F., Ibid., **1933**, No. 8, 50.
(10) Yushkevitch, N. F., Karzhavin, V. A., Avdeeva, A. V., and Nikol'skaya, yu, P., J. Chem. Ind., (Moscow), **1934**, No. 2, 33.

Acknowledgment

The writers wish to thank the Union Oil Company of California for the opportunity of publishing this paper.

Method for Producing Isoprene from Hydrocarbons Presented at Chemical Engineers Meeting

A NEW METHOD of producing isoprene from petroleum hydrocarbons, and the dehydrogenation of butane were among subjects of interest to petroleum technologists discussed at the 36th semi-annual meeting of the American Institute of Chemical Engineers in Cleveland, May 14-16.

J. M. Mavity of Universal Oil Products Co., Chicago, explained a recently developed method for production of isoprene from isopentanes and isopentenes. Isoprene, heretofore produced commercially from turpentine, is the basic compound of natural rubber and an important ingredient of synthetic Butyl rubber. Yields as high as 80% have been obtained. Pressures below atmospheric (as low as 80 mm.), increased temperatures (up to 660°C.), and feed stock high in olefinic content tend to increase yields.

Conversion of butane to butylene by means of catalytic dehydrogenation, processing methods involved, and engineering problems encountered were described by J. W. McCausland, also associated with U.O.P.

In another paper presented before the institute, H. H. Hummel of Pan American Refining Corp., Texas City, Texas, outlined a simplified method for plate-to-plate calculations for multicomponent fractionation. In describing his method, Mr. Hummel claimed that it would be of "most value in process design and technical service work in the petroleum and petroleum chemicals industries."

Abstracts of these three papers and of two others of interest to petroleum refinery men are given below:

Butane Dehydrogenation

C. C. Watson, F. O. Newton, E. H. McGrew, J. W. McCausland and Louis S. Kassel, Universal Oil Products Co., Chicago.

Butane dehydrogenation has been in operation since 1940. Numerous interesting engineering problems were encountered in developing the process through the pilot plant stage, some of which are discussed herein. The catalyst used has the essential characteristics of high activity, good selectivity, thermal and mechanical stability, and low cost. The process temperature and pressure are determined by consideration of thermodynamic equilibrium and the ratio of thermal to catalytic reaction rates. The plant design is controlled by the high endothermic heat of reaction, the exothermic heat of regeneration, and the necessity of low pressure drop. These considerations lead to a heat exchanger type of reactor, with the catalyst in tubes heated and cooled by the circulating flue gas. A flow diagram is given, and the plant operation is described.

° ° °

Production of Isoprene *By Catalytic Dehydrogenation*

Julian M. Mavity and Earl E. Zetterholm, Universal Oil Products Co., Chicago.

A selective method for producing isoprene by the catalytic dehydrogenation of either isopentane, isopentenes, or mixtures of these components is described. U.O.P. commercial dehydrogenation catalyst is employed. Isoprene recycle yields, conversion per pass, carbon formation, and other pertinent data have been calculated from a series of once-through laboratory tests, and correlated to show the effect of the process variables. Decreasing pressure from atmospheric to 80 mm. results in a very marked improvement in both the selectivity and extent of the dehydrogenation. Increasing temperature or decreasing liquid hourly space velocity increases conversion. The correlation covers a temperature range of 615°C to 660°C., a space velocity range of 1.5 to 12, and has been limited to a single process period length of 30 minutes. Feed stock compositions ranging from pure isopentane to "pure isopentenes" have been employed, those of higher olefinic content giving more favorable results. Under the most favorable conditions isoprene recycle yields of 80% or higher are indicated.

° ° °

Multicomponent Fractionation: A Simplified Approach to Plate-to-plate Calculations

H. H. Hummel, Pan American Refining Corp., Texas City, Texas.

Rigorous results for multicomponent fractionation are obtained by what is essentially a modified, more convenient plate-to-plate calculation. The trial and error is thrown primarily into an assumed temperature gradient throughout the column, rather than into the distribution of components. Successive approximations are made to the temperature gradient until a satisfactory check is obtained, only two or three trials usually being necessary.

The calculation is particularly suited for predicting the performance of an existing tower, although it is also useful for calculating the number of plates required for a desired separation. It will be of greatest value where the usual plate-to-plate calculations are otherwise required, especially when there are a number of distributed components.

A new form of absorption factor chart, for use where rapid approximate results are desired, is presented.

While major attention is given to ideal systems, a suggested approach for certain types of non-ideal systems is outlined.

° ° °

Heat Transfer Equipment

P. W. Blaylock, Shawinigan Chemicals Ltd., Shawinigan Falls, Quebec

Various types of multitubular heat transfer equipment used in the chemical industry are described briefly.

Details of the assembly and fabrication of this type of equipment are discussed and reference is made to various construction codes and rules which govern the mechanical design and proportion of the various elements.

Some of the practical considerations governing the selection of tube diameter, tube length, baffle arrangement and general design for a given application are discussed and illustrated.

° ° °

Process Development

H. L. Barneby, Blaw-Knox Division of Blaw-Knox Co., Pittsburgh.

A process development program is aided in its course from inception to commercial realization by dividing it into a definite series of steps. The completion of each step should prove it worth while to proceed to the next and indicate the course of further action. The commercial plant should be visualized before the pilot plant is designed so that it can be built to supply the requisite data. Mistakes cost less when made early in the program.

° ° °

Consultants' Directory Available

The Association of Consulting Chemists and Chemical Engineers, Inc., announce the publication of a new eighth edition (1944) of their Classified Directory. The directory includes listings by field, membership, company affiliations of members, geographical location of members, and a statement from each member on his organization's qualifications, scope, and activities. Copies are available free on request to the Association at 50 East 41 St., New York 17, N. Y.

Codimer Unit Built From Salvage

USING approximately 80% salvage material, The Pure Oil Co. has built a catalytic polymerization—codimer—unit at its Heath, Ohio, refinery which has been operating successfully for more than a year. The only items of new equipment consisted principally of necessary piping, a furnace and a few automatic control instruments, according to company engineers.

An old Cross cracking unit reaction chamber was made into a catalyst vessel.

A depropanizer was fabricated from 24 in. I.D. extra heavy steel pipe.

The debutanizer was once an absorber, drafted from the salvage pile for "essential war work."

The finished product storage was once a clay tower used in gasoline treating.

Tanks, exchangers and other vessels also came from the salvage yard, were patched up as needed, and put to service once more.

Old Equipment Revamped

The most interesting feature of the construction was the revamping of an old Cross cracking unit reaction vessel into a catalyst chamber. The old vessel was 52 in. I.D. by 44 ft., 9 in. long; its walls were 5½ in. thick. Formerly it was used in a horizontal position, but for polymerization it had to be erected vertically, to stand on its own foundation.

Provision for three catalyst beds 8 ft. deep were made in the old Cross reactor, giving the vessel a capacity of approximately 20,000 lb. of catalyst. However, experience proved this amount of catalyst was more than required for "normal" operations; hence the usual charge now is about 12,000 lb., still divided into three beds. Space between the beds, filled with gravel, broken ceramic packing or other inert material, is used as a quench zone. Thermocouples are placed throughout the beds to record temperatures and warn against development of "hot spots."

Instead of trays, the depropanizer is filled with ceramic packing for fractionation. Several lengths of sound, extra-heavy steel pipe, 24 in. I.D., were welded together to form the 57-ft. tower. Four sections of 10-ft. length are filled with 1½-in. Raschig rings in lieu of bubble caps and trays.

Operation and Products

Flow in the unit corresponds closely to that in the standard U.O.P. polymerization unit using phosphoric acid catalyst. Overhead gas and condensate charge for the polymerization unit are obtained from the cracked gasoline stabilizer. This tower is run as and serves for a debutanizer.

Cracked gasoline stabilizer overhead vapors are compressed to 350 lb. per sq. in. gauge and, with any condensate formed, serve as charge to a depropanizer operating at this pressure. Propanes and lighter are removed as overhead and discharged to the plant fuel-gas system. Butanes and butenes are removed as bottoms.

The B-B cut, consisting of normal and isobutane, the two butenes and isobutene, is caustic- and water-washed to remove any sulfur compounds present, down to 0.05% total sulfur, maximum. This is accomplished in the conventional manner by means of orifice mixers and settling tanks.

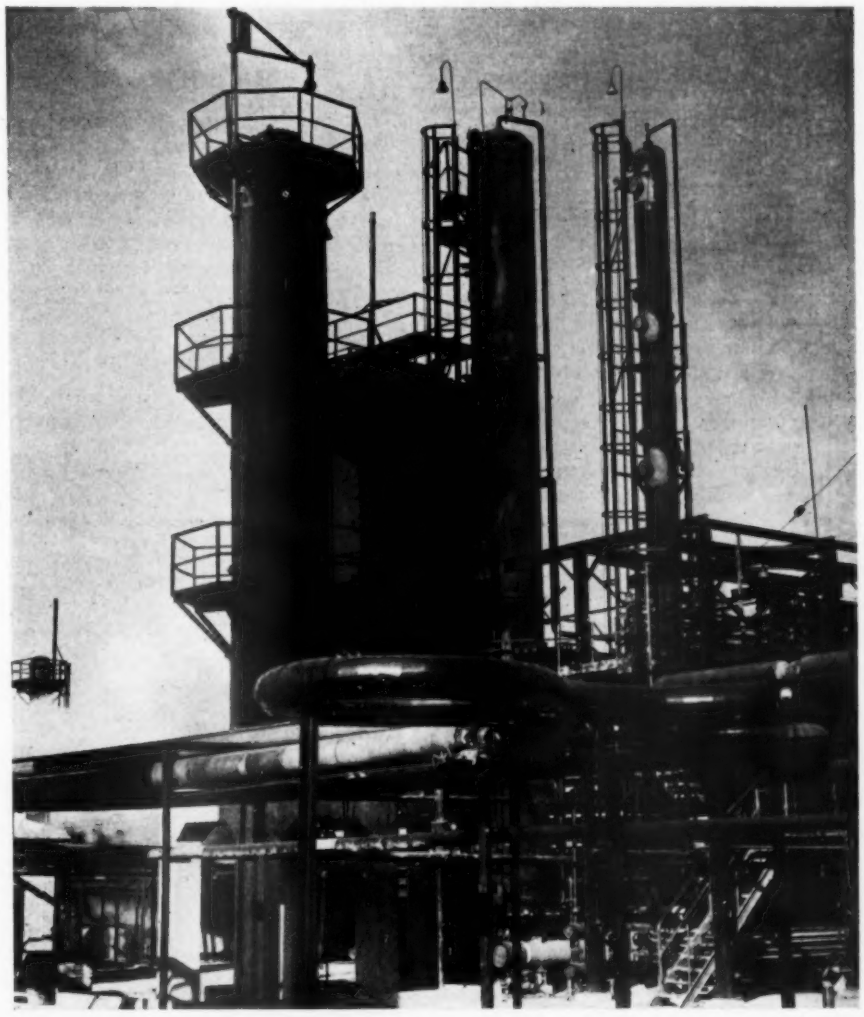
Charge for the reactor, as shown in Table 1, consists of the prepared B-B feed amounting to 683 b/d with 1317 b/d of recycle, a total feed of approximately 2000 b/d. It is heated to 300°F. before charging to the catalyst chamber at 650 psig. Since the optimum range for selective polymerization of the butenes to the desired octylenes—codimer—has been determined as 300-320°F., interbed quenching is required to prevent excessive temperature rise from the exothermic reaction.

Products of the reaction are butanes and codimer. Overhead from the reactor, at an efflux temperature of 310°F., is charged directly to the debutanizer, operating at 80 psig. Codimer, of 5 lb. Reid vapor pressure, is recovered as bottoms while spent butanes go overhead

TABLE 1

(Codimer Unit, Operating Conditions)

	b/d	Temp., °F.	psig
Depropanizer:			
Feed	1020	185	350
Top		123	
Bottom	683	216	
Catalyst Chamber:			
Prepared B-B	683		
Recycle butanes	1317		
Total Feed	2000		
First Bed, in		300	650
First Bed, out		330	
Second Bed, in		300	
Second Bed, out		320	
Third Bed, in		300	
Third Bed, out		310	
Debutanizer:			
Top		138	80
Reboiler		300	
Polymer	180		



General view of codimer unit built largely from salvaged material. Picture shows, left to right, catalyst chamber, polymer storage tank, debutanizer and depropanizer. Accumulators and exchangers are visible in foreground

for use as recycle, inter-bed reactor quench, or for blending with motor gasoline.

Codimer is stored without further treatment for shipment to plants having hydrogenation facilities. A typical inspection of the product is shown in Table 2.

Control of the entire unit is automatic, by means of temperature and pressure recorders, controllers, and flow-meters. Only one operator is required to handle the unit on each shift.

TABLE 2

(Physical Inspection of Codimer Produced)

Reid Vapor-pressure, lb.	4.5
A.P.I. Gravity, deg.	61.5
Total Sulfur, %	0.03
Distillation, °F.	
I.B.P.	108
5%	174
10%	206
30%	228
50%	234
70%	244
90%	324
95%	370
E.P.	388

Correction

In the article entitled "Alien Patents Available to U. S. Industry Cover Many Petroleum Refining Processes" in the June 7 Technical Section of NPN, p. R-394, the office of Alien Property Custodian calls to our attention an error in the case number of one of the abstracts. The first abstract listed on p. R-395 should be number TC-217, instead of TC-214 as given in the original report and reported in NPN.

Storage Stability of Blends Of Amyl Nitrate with Diesel Fuels

(The following comments were received by NPN from Mr. E. M. Nygaard, Research and Development Division, Socony-Vacuum Oil Co., Paulsboro, N. J., on a recent article appearing in the Technical Section of National Petroleum News—"Developments to Raise Ignition Qualities of High-Speed Diesel Fuels Explained" (May 3, 1944, pp. R-284-294). —Editor)

J. S. BOGEN and G. C. Wilson, (National Petroleum News, Technical Section, May 3, 1944, page R-290) have reported that a number of investigators, themselves included, have found that commercial amyl nitrate is stable in storage either when blended with a fuel or in the concentrated form. They further state that fuel blends stored for over three years have shown no drop in cetane number or change in other properties due to the addition of the commercial amyl nitrate.

The above statements are probably true for dry storage of such blends but do not hold when the blend of fuel and amyl nitrate are in contact with water. This condition prevails in bulk storage even though water is not deliberately added. The following data show that within a period of three months a blend of a California straight-run Diesel fuel and amyl nitrate stored in the presence of water in a steel container had lost practically all of the cetane number improvement attributable to the additive. This condition probably results from the hydrolysis of the amyl nitrate in the presence of water.

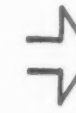
The fuel used in the tests tabulated below possessed the following characteristics:

Gravity	31.6
Flash Point (Pensky-Martens °F)	174.
Aniline Point, °F	141.5
A.S.T.M. Distillation	
Initial °F.	383
10%	458
90%	650
End Point	728
Diesel Index	44.7
Cetane No.	41.5

Cetane Number Depreciation of a Blend of Amyl Nitrate and a Straight-Run California Diesel Fuel Upon Storage in the presence of Water in a Steel Container

% of Amyl Nitrate Added	Cetane No. Before Storage	Cetane No. After 3 Mos. Storage	Loss in Cetane No. After 3 Mos. Storage
None	41.5	43.0	—
"	41.5	42.1	—
0.5	51.1	43.2	7.9
1.0	52.4	44.5	7.9

In each of the above experiments 150 cc of water were added to 1800 g of the oil. Storage was conducted at the prevailing atmospheric temperature.



This striking view of a gas cycling and processing plant was made for Petroleum Engineering, Inc., by Robert Yarnall Richie. The plant is one of many designed and constructed by this company during the past 15 years of continuous service to the industry, including cycling, repressuring, vapor recovery, and pure hydrocarbon plants. Petroleum Engineering, Inc. Offices: Tulsa and Houston.

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Thermodynamic Properties of Organic Compounds—Estimation from Group Concentrations

By J. W. Andersen, G. H. Beyer*, and K. M. Watson**

(Article 3 in a Series)

A method is presented whereby the thermodynamic properties of organic compounds in the ideal gaseous state are resolved into contributions attributable to atomic groups. From the resulting tables the properties of complex molecules are readily estimated by summation of the contributions of their component groups. Contributions are developed for heats of formation at 25°C, entropies at one atmosphere and 25°C, and the constants of the three-term heat capacity equation for the ideal gas. Heats of formation and entropies calculated from the contributions ordinarily deviate from the best experimental values by less than 4 kcal per g-mole and 2 entropy units respectively. Exceptions are the heats of formation of the lowest members of highly polar series such as the acids, aldehydes and alcohols. Calculated heat capacities differ from the accepted values by less than 5% in most cases.

MANY empirical rules have been proposed for estimation of thermodynamic properties by analogy to compounds of known properties or by the summation of structural contributions. Kharasch and Sher[27, 28] developed a simple method for estimating heats of combustion of liquid organic compounds which requires only a knowledge of the structural formula. This method has proved useful, but fails to take into account the differences between isomers and is applicable only to compounds of carbon, hydrogen, oxygen and nitrogen.

A more general method for estimating heats of formation and reaction in the ideal gaseous state was proposed by Pauling[33] on the basis of the assignment of a definite energy of formation to each valence bond. This method appears to be somewhat less reliable than that of Kharasch and Sher and is subject to the same disadvantage of failing to take into account differences between isomers. This problem was considered by Ewell[13] who suggested simple rules for correcting the heats of formation and entropies of hydrocarbons for structural branching and unsaturation.

Various empirical methods for estimating entropies are discussed by Wenner[48], who summarizes useful rules involving molecular weight and structural analogies.

Rossini[39] in presenting new values of the heats of formation of some hydrocarbons suggests that precise estimation of such data from structure will be possible when more experimental results of sufficient reliability are available. Such an equation is developed for the higher normal paraffins.

Because none of these schemes is satisfactory from the standpoints of both generality and accuracy, this study was undertaken in an effort to develop methods of approximation which will be useful for engineering calculations until more precise methods are available.

To serve as a basis for the development of a generalized method of approximation, the data of the literature were assembled for the heats of combustion, heats of formation, entropies and heat capacities of organic compounds of all types. From these data, heats of formation in the ideal gaseous state at 25°C, entropies of the ideal gaseous state at 1 atmosphere and 25°C, and constants for the heat capacity equations of the ideal gas were developed by the following conversion procedures:

Heats of Formation—All heats of formation in the ideal gaseous state reported by Rossini and co-workers[38, 39, 40] were accepted without modification. The other principal sources of data are indicated in the references of Table VI. Heat of combustion data were converted to heats of formation by use of the heats of formation of the combustion products, recommended by Hougen and Watson[22]. Heats of formation in the gaseous state were calculated from those of the liquid state by addition of the heat of vaporization at 25°C. Direct experimental data on heats of vaporization from the International Critical Tables[23] were used as far as possible. Where data at 25°C were not available, the heat of vaporization at the boiling point was corrected to 25°C by the empirical equation proposed by Watson[47]. If no experimental value was available for the heat of vaporization at the normal boiling point, it was estimated from the boiling point and critical point by combination of the Clapeyron equation, the Calingaert-Davis vapor pressure equation and the reduced compressibility factor correlation[47]. Where critical data were not available, they were estimated by the methods of Meissner and Redding[29].

Heats of formation in the solid state were converted to the gaseous state by calculating the heat absorbed in heating the solid to its melting point, fusing it to the liquid state, vaporizing the liquid at the melting point and cooling the vapors to 25°C. This procedure required knowledge of the heat capacities of the solid and the gas and heat of fusion, in addition to some basis for estimating the heat of vaporization by the methods referred to in the preceding paragraph.

Although these conversion procedures were probably not highly accurate in

*Department of Chemical Engineering, University of Wisconsin, Madison. Messrs. Anderson and Beyer are now serving with the Navy.

Coming Articles in Process Engineering Series

"Thermodynamics of Solutions—Ideal Systems at High Pressures," by B. W. Gamson and K. M. Watson, is the fourth in this series of articles being presented exclusively in the Technical Section of NATIONAL PETROLEUM NEWS. It will appear in the August 2 issue. The article in this issue is the third.

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some cases, it is believed that the errors introduced are less than those probably involved in the determination of the heat of combustion.

Entropies—The principal source of entropy data was the refined statistical calculations of Pitzer and co-workers[19, 35, 36, 37] from which entropies in the ideal gaseous state are obtained directly. Other sources of data are indicated by the references in Table VII. Entropies for several olefines were obtained by combining the values developed by Ewell and Hardy[15] for the differences between the entropies of isomeric olefins and paraffins with the data of Pitzer for the paraffins.

Entropies for the liquid state were converted to the gaseous state by adding the entropy of vaporization at 25°C and the correcting for ideal compression to 1 atmosphere. Where vapor pressure data were not available they were estimated by the empirical equations of Gamson and Watson[18]. Heats of vaporization were obtained by combining these equations with the Clapeyron equation[16].

Entropies for the solid state were converted to the gaseous state by the same procedure described for heats of formation except that vapor pressures and heats of vaporization were estimated from the more accurate Gamson and Watson equations.

Although conversions in many cases were based on empirical generalizations, comparison of the results of these correlations with reliable experimental data indicates that the errors introduced should not be more than a few tenths of an entropy unit.

Heat Capacities—The principal source of heat capacity data was the summary of heat capacity equations of Spencer and Flannagan[43]. Additional heat capacity equations for hydrocarbons were calculated from the enthalpy data of Pitzer[35, 36, 37]. Other sources of experimental heat capacity data are indicated by the references in Table VIII.

Because of the lack of high temperature heat capacity data it was necessary to resort to the generalized methods of Bennewitz and Rossner[7], Dobratz[9], and Stull and Mayfield[46] in order to develop heat capacity contributions for several nonhydrocarbon groups. These methods appear to be reliable for the lower, but not the lowest, homologues of a variety of organic series. Accordingly they are employed to estimate heat capacity equations for homologues containing 2, 3 or 4 carbon atoms and group contributions were derived on this basis. It is believed that the heat capacities of large molecules are more accurately estimated from these basic values for small molecules combined with secondary group contributions based on the hydrocarbon data of Pitzer than by direct application of the Dobratz or Stull and Mayfield methods.

For the derivation of the heat capacity contributions of non-hydrocarbon groups, the frequency assignments of Stull and Mayfield were used, supplemented by those of Bennewitz and Rossner for non-hydrocarbon bonds. The calculations were carried out by the summation method recommended by Stull and Mayfield and three-term equations ($c^\circ_p = a + bT + cT^2$) were fitted to the resultant total heat capacity values rather than attempting to assign equation constants to the individual bond contributions as recommended by Fugassi and Rudy[17] and Dobratz[9].

Group Contributions

The values of the heats of formation, entropies and heat capacity constants were resolved into group contributions on the following basis:

Each compound is considered as composed of a basic group which is modified by the substitution of other groups for atoms comprising it. For example, all paraffin hydrocarbons may be considered as derived from methane by successive substitution of CH_3 groups for hydrogen atoms. Similarly, any secondary amine can be considered as derived from the base group $NH(CH_3)_2$. The contributions of nine base groups are given in Table I.

The contributions resulting from the primary substitution of a methyl group for a hydrogen atom in any one of the base groups is given in Table II. In the cases of benzene, naphthalene and cyclopentane, the base group contains several carbon atoms and successive substitutions on different carbon atoms involve different contributions depending upon the number and position of the substituted groups. For the naphthenes the terms ortho, meta and para are taken as indicating a minimum separation of the two substituted groups by, respectively, 0, 1 and 2 intermediate carbon atoms in the ring.

TABLE I—Base Group Contributions

Group	$\Delta H^\circ_{f298.1}$(g) (kcal/g-mole)	$S^\circ_{298.1}$(g) (cal)/(g-mole) (°K)	a	$b \times 10^3$ (Ideal gas at T°K)	$c \times 10^6$ (Ideal gas at T°K)
Methane	—17.9	44.5	3.42	17.85	— 4.16
Cyclopentane	—21.4	70.7	2.62	82.67	—24.72
Benzene	18.1	64.4	0.23	77.83	—27.16
Naphthalene	35.4	80.7	3.15	109.40	—34.79
Methylamine	— 7.1	57.7	4.02	30.72	— 8.70
Dimethylamine	— 7.8	65.2	3.92	48.31	—14.09
Trimethylamine	—10.9	...	3.93	65.85	—19.48
Dimethyl ether	—46.0	63.7	6.42	39.64	—11.45
Formamide	—49.5	...	6.51	25.18	— 7.47

TABLE II—Contributions of Primary CH_3 Substitution Groups

Base Group	$\Delta H^\circ_{f298.1}$(g) (kcal/g-mole)	$\Delta S^\circ_{298.1}$(g) (cal)/(g-mole) (°K)	Δa	$\Delta b \times 10^3$ (Ideal gas at T°K)	$\Delta c \times 10^6$ (Ideal gas at T°K)
1. Methane	— 2.2	10.4	—2.04	24.00	—9.67
2. Cyclopentane					
a. First substitution outside ring	— 5.2	11.5	—0.07	18.57	—5.77
b. Second substitution: ortho	—12.2	...			
meta	— 8.4	...	—0.24	16.56	—5.05
para	— 7.1	...			
c. Third substitution	— 7.0	...	...	...	...
d. Enlargement of ring	— 9.3	.7	—1.04	19.30	—5.79
3. Benzene and Naphthalene					
a. First substitution outside ring	— 4.5	12.0	0.36	17.65	—5.88
b. Second substitution: ortho	— 6.3	8.1	5.20	6.02	1.18
meta	— 6.5	9.2	1.72	14.18	—3.76
para	— 8.0	7.8	1.28	14.57	—3.98
c. Third substitution (sym)	...	8.0	0.57	16.51	—5.19
4. Methylamine	— 5.7	...			
5. Dimethylamine	— 6.3	...	—0.10	17.52	—5.35
6. Trimethylamine	— 4.1	...			
7. Formamide					
Substitution on C atom	— 9.0	...	6.11	—1.75	+4.75

TABLE III—Secondary Methyl Substitutions

A	B	$\Delta H^\circ_{f298.1}$(g) (kcal/g-mole)	$\Delta S^\circ_{298.1}$(g) (cal)/(g-mole) (°K)	Δa	$\Delta b \times 10^3$ (Ideal gas at T°K)	$\Delta c \times 10^6$ (Ideal gas at T°K)
1	1	—4.5	9.8	—0.97	22.86	— 8.75
1	2	—5.2	9.2	1.11	18.47	— 6.85
1	3	—5.5	9.5	1.00	19.88	— 8.03
1	4	—5.0	11.0	1.39	17.12	— 5.88
1	5	—6.1	10.0	0.10	17.18	— 5.20
2	1	—6.6	5.8	1.89	17.60	— 6.21
2	2	—6.8	7.0	1.52	19.95	— 8.57
2	3	—6.8	6.3	1.01	19.69	— 7.83
2	4	—5.1	6.0	2.52	16.11	— 5.88
2	5	—5.8	2.7	0.01	17.42	— 5.33
3	1	—8.1	2.7	—0.96	27.47	—12.38
3	2	—8.0	4.8	—1.19	28.77	—12.71
3	3	—6.9	5.8	—3.27	30.96	—14.06
3	4	—5.7	1.7	—0.14	24.57	—10.27
3	5	—9.2	1.3	0.42	16.20	— 4.68
1	—0— in ester or ether	—7.0	14.4	—0.01	17.58	— 5.33
Substitution of H of OH group to form ester		+9.5	16.7	0.44	16.63	— 4.95

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If more than one substitution is made on a single carbon atom of a base group the additional contributions are treated as secondary substitutions and evaluated from Table III.

The contributions resulting from the secondary substitution of methyl groups for hydrogen atoms are classified in Table III according to (*A*) the type of carbon atom on which the substitution is made and (*B*) the highest type number of an adjacent carbon atom. The carbon atom types are defined on the basis of the number of hydrogen atoms attached. Thus—

Type 1 CH_3

Type 2 CH_2

Type 3 CH

Type 4 C

Type 5 C atom in benzene or naphthalene ring

Two special secondary substitutions are defined in Table III for use in calculating the properties of esters and ethers. One is the substitution of a methyl group for the hydrogen of a carboxyl group to form a methyl ester. The other is the substitution of a methyl group for one of the hydrogens of a methyl ester or ether to form an ethyl ester or ether. If additional substitutions are made on this same carbon atom the contributions are evaluated from the corresponding values of *A* and *B* based on the type numbers of the carbon atoms involved.

In Table IV are the contributions resulting from the substitution of multiple bonds for single bonds between two carbon atoms of types *A* and *B* respectively. An additional contribution must be added for each pair of conjugated double bonds formed by such substitutions.

In Table V are the incremental contributions resulting from the substitution of various groups for one or two methyl groups. Thus, if a methyl group is replaced by an OH group the contribution to the heat of formation is −32.7. If two methyl groups are replaced by an oxygen atom to form an aldehyde the contribution is −12.9. It will be noted that the phenyl group is included in Table V in addition to being designated as a base group in Table I. This substitution contribution is used in calculating the properties of complex compounds in which several base groups are combined as, for example, in polybasic aromatic acids.

The contributions to heats of formation resulting from substitution of chlorine for methyl groups vary with the number of substitutions made on a single carbon atom. Corresponding variations were not found for the contributions to entropy or heat capacity or for the substitution of the other halogens. As noted in the table a correction must be applied to the entropies calculated for the halogenated methanes. In general the calculated results tend to be uncertain for single carbon atom compounds.

The suggested sequence of operations in estimating the properties of a complex compound is as follows:

1. Select the base group and determine its contribution from Table I. Where a choice of base group is possible, select the group having the largest entropy contribution. Proceed to build up the desired compound with as few substitutions as possible.
2. Add the contributions given in Tables II and III which result from all CH_3 substitutions required to establish the carbon skeleton of the compound. In this operation the longest straight chain should be built up first and then the longest side chain. Where the same compound may be arrived at by alternate substitutions an average result is used.
3. Add the contributions from Table III which result from additional CH_3 substitutions in the positions occupied in the compound by other groups which are listed in Table V.
4. Add the contributions given in Table IV which result from multiple bonds.
5. Add the incremental contributions given in Table V which result from replacement of CH_3 groups by substitution groups.

Examples of Estimations

Illustration 1. Approximate the standard heat of formation $\Delta H_{f298.1}(g)$ of 2,2,4-trimethylpentane at 25°C:

Base group (methane) . .		−17.9
Primary CH_3		− 2.2
Secondary CH_2 substitutions:		
A	*B*	
1	1	− 4.5
1	2	− 5.2
1	2	− 5.2
2	2	− 6.8
2	2	− 6.8
3	2	− 8.0
		−56.6 kcal

The value found by Rossini and coworkers[39] is −56.2 kcal.

Illustration 2. Approximate $\Delta H_{f298.1}(g)$ for dimethyl phthalate:

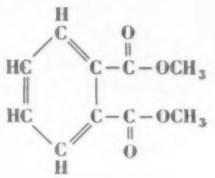

TABLE IV—Multiple Bond Contributions

A	Type of Bond	B	$\Delta H°_{f298.1}(g)$ (kcal/g-mole)	$\Delta S°_{298.1}(g)$ (cal)/(g-mole)(°K)	Δa	$\Delta b \times 10^3$ (Ideal gas at T°K)	$\Delta c \times 10^6$ (Ideal gas at T°K)
1	=	1	32.8	—2.1	1.33	—12.69	+ 4.77
1	=	2	30.0	0.8	1.56	—14.87	+ 5.57
1	=	3	28.2	2.2	0.63	—23.65	+13.10
2	=	2	28.0	—0.9	0.40	—18.87	+ 9.89
2	(cis) =	2	28.4	—0.6	0.40	—18.87	+ 9.89
2	(trans) =	2	27.5	—1.2	0.40	—18.87	+ 9.89
2	=	3	26.7	1.6	0.63	—23.65	+13.10
3	=	3	25.5	.	—4.63	—17.84	+11.88
Correction for each pair of conjugated double bonds			—3.8	—10.4		approximately zero	
1	≡	1	74.4	—6.8	5.58	—31.19	+11.19
1	≡	2	69.1	—7.8	6.42	—36.41	+14.53
2	≡	2	65.1	—6.3	4.66	—36.10	+15.28
Correction for double bond adjacent to aromatic ring			—5.1	—4.3		approximately zero	

TABLE V—Substitution Group Contributions

Group	$\Delta H°_{f298.1}(g)$ (kcal/g-mole)	$\Delta S°_{298.1}(g)$ (cal)/(g-mole)(°K)	Δa	$\Delta b \times 10^3$ (Ideal gas at T°K)	$\Delta c \times 10^6$ (Ideal gas at T°K)
—OH (aliphatic, meta, para)	—32.7	2.6	3.17	—14.86	+ 5.59
—OH (ortho)	—47.7	.	.	.	.
—NO_2	1.2	2.0	6.3	—19.53	+10.36
—CN	39.6	13.1	3.64	—13.92	+ 4.53
—Cl	0 for first Cl on a carbon; 4.5 for each additional	0*	2.19	—18.85	+ 6.26
—Br	10.0	3.0*	2.81	—19.41	+ 6.33
—F	—35.0	—1.0*	2.24	—23.61	+11.79
—I	24.8	5.0*	2.73	—17.37	+ 4.09
=O (aldehyde)	—12.9	—12.3	3.61	—55.72	+22.72
=O (ketone)	—13.2	—2.4	5.02	—66.08	+30.21
—COOH	87.0	15.4	8.50	—15.07	+ 7.94
—SH	15.8	5.2	4.07	—24.96	+12.37
—C_6H_5	32.3	21.7	—.79	53.63	—19.21
—NH_2	12.3	—4.8	1.26	—7.32	2.23

*Add 1.0 to the calculated entropy contributions of halides for methyl derivatives, e.g. methyl chloride = 44.4 (base) + 10.4 (primary CH_3) — 0.0 (Cl substitution) + 1.0.

Base group (benzene) .	+ 18.1
Primary CH_3	− 4.5
Ortho CH_3	− 6.3
—COOH	− 87.0
—COOH	− 87.0
CH_3 replacing H of —COOH	+ 9.5
CH_3 replacing H of —COOH	+ 9.5
	−147.7 kcal

The value of $\Delta H_{f298.1}$ calculated from the heat of combustion listed by Kharasch[27] is −147.1 kcal/g-mole.

Illustration 3. Approximate the entropy of 2,2,3,3-tetramethyl butane:

a. Base group (methane)			44.5
Primary CH_3			10.4
Secondary CH_3 substitutions:			
	A	*B*	
	1	1	9.8
	1	2	9.2
	2	2	7.0
	2	3	6.3
	3	3	5.8
	3	4	1.7
			94.7

b. Base group (methane)			44.5
Primary CH_3			10.4
Secondary CH_3 substitutions:			
	A	*B*	
	1	1	9.8
	1	2	9.2
	2	2	7.0
	3	2	4.8
	2	4	6.0
	3	4	1.7
			93.4

The average result for the entropy of 2,2,3,4-tetramethyl butane is 94.05 cal/g-mole (°K), which is in agreement with the value found by Pitzer[35].

Illustration 4. Approximate the entropy of 1,2-dibromoethane:

Base group (methane)			44.5
Primary CH_3			10.4
Secondary CH_3 substitutions:			
	A	*B*	
	1	1	9.8
	1	2	9.2
Br substitution			3.0
Br substitution			3.0
			79.9

This result is in agreement with the value reported by Pitzer[34].

Illustration 5. Calculate the heat required to raise one mole of 2,3-dimethylpentane in the ideal gaseous state from 298.1°K. to 1000°K:

		a	$b \times 10^3$	$c \times 10^5$
Base		3.42	17.85	− 4.16
Primary		−2.04	24.00	− 9.67
A	*B*			
1	1	−0.97	22.86	− 8.75
1	2	1.11	18.47	− 6.85
1	2	1.11	18.47	− 6.85
2	2	1.52	19.95	− 8.57
2	3	1.01	19.69	− 7.83
		5.16	141.29	−52.68

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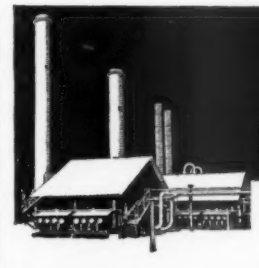

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$$H_{1000}-H_{298}$$

$$=\int_{298.1}^{1000}[5.16+(141.29\times10^{-3})T-$$

$$(52.68\times10^{-6})T^2]dT$$

$$=5.16T+(70.64\times10^{-3})T^2-$$

$$(17.56\times10^{-6})T^3\Big|_{298.1}^{1000}$$

$$=50{,}520 \text{ cal/g-mole}$$

Pitzer [35] reports a value of 50,550 cal/g-mole.

In Tables VI, VII and VIII are values of heats of formation, entropies, heat capacities and relative enthalpies for a variety of compounds which were calculated from group contributions for comparison with the indicated experimental values. Many additional compounds were considered in evaluating the contributions. Those included in the table were selected in an effort to present comparisons representative of the ranges of errors to be expected in the use of the method.

Utility of Method

The approximation of thermodynamic properties from group contributions is not based on well defined theoretical principles and must be recognized as an empirical correlation which may result in serious errors in some cases. Ordinarily, the calculated standard heats of formation differ from the experimental values by less than 4 kilocalories per gram mole and the entropy values by less than 2 units. The data on heat capacities are so uncertain that it is difficult to estimate the probable errors of the calculated results. At moderate temperatures the deviation from the better experimental values is generally less than 5% while at higher temperatures the uncertainty increases.

Heats of reaction and entropy changes in the ideal state at 25°C are readily obtained by subtracting the heats of formation or entropies of the reactants from those of the products. Thus,

$$\Delta H^\circ_{298}=\Sigma(\Delta H^\circ_{f298})_p-\Sigma(\Delta H^\circ_{f298})_r \quad (1)$$

$$\Delta S^\circ_{298}=\Sigma(S^\circ_{298})_p-\Sigma(S^\circ_{298})_r \quad (2)$$

where the subscripts p and r refer to the products and reactants respectively. From these values heats of reaction and entropy changes at any other temperature are obtained from the heat capacity equations.

$$\Delta H^\circ_T=I_H+\Delta aT+\tfrac{1}{2}\Delta bT^2+\tfrac{1}{3}\Delta cT^3 \quad (3)$$

$$\Delta S^\circ_T=I_S+\Delta a\ln T+\Delta bT+\tfrac{1}{2}cT^2 \quad (4)$$

where

I_H and I_S are constants of integration which are evaluated from ΔH°_{298} and ΔS°_{298} respectively.

Δa etc. $=\Sigma(a)_p-\Sigma(a)_r$, etc.

By combining Equations 3 and 4 with the definition of free energy, an expression for the standard free energy change and the equilibrium constant is obtained. Thus,

$$-R\ln K=\Delta G^\circ/T$$

$$=I_H/T+(\Delta a-I_S)-\Delta a\ln T-$$

$$\tfrac{1}{2}\Delta bT-\tfrac{1}{6}\Delta cT^2 \quad (5)$$

where

K = thermodynamic equilibrium constant
R = gas law constant
ΔG° = standard free energy change at temperature T°K

The heat of formation and heat capacity values calculated from group contributions are believed to be of sufficient accuracy for satisfactory use in the energy balances required in the design and operation of many processes. The most serious errors from the engineering viewpoint occur when dealing with processes in which the heat of reaction is relatively small and large percentage errors result from small errors in the heats of formation.

The thermodynamic data calculated from group contributions are not sufficiently accurate for satisfactory estimation of anything better than the order of magnitude of reaction equilibrium constants by Equation 5. This is evident from the fact that in order to establish an equilibrium constant with less than a 10% error at 300°K the standard free energy change must be known with an error of less than 0.06 kilocalories per gram mole. This corresponds to a permissible error of the same amount in the heat of reaction or to an error of less than 0.2 units in the entropy change accompanying the reaction. This degree of accuracy is approached only in the most accurate of recent measurements of heats of formation.

It can be concluded that equilibrium constants calculated from any but the most precise heat of formation and entropy data can be used directly only for predicting the general feasibility of reactions or for determining the ranges of operating conditions in which reverse reactions are negligible. Data approximated from group contributions should be useful for these purposes and in many cases are believed to be superior to the available experimental values.

Where accurate equilibrium data are required, the standard entropy and heat capacity changes may be approximated from group contributions with fair accuracy. A single experimentally determined equilibrium constant then permits calculation of a standard heat of formation value which is consistent with the estimated entropy change. In this manner equilibrium constants may be calculated with satisfactory accuracy over moderate ranges of conditions from only

a single experimental value.

As previously mentioned, it is believed that heat capacities of complex molecules containing more than 5 carbon atoms are better estimated from group contributions than by direct application of heat capacity equations based on generalized bond frequency assignments. The latter methods may be used to estimate the heat capacities of additional small base groups not covered in this investigation which can then be extended to large molecules by means of the substitution group contributions. Fair approximations to entropies of small, simple base groups can also be derived from these generalized frequencies combined with moment of inertia calculations. This general procedure is described by Aston[1]. Group contributions may be used to extend the results of such calculations to larger molecules for which direct calculations are tedious and uncertain.

° ° °

Acknowledgment

The work herein reported was made possible through the financial support of the Wisconsin Alumni Research Foundation.

Nomenclature

a, b, c = constants in molal heat capacity equation $c_p = a + bT + cT^2$

$\Delta a, \Delta b$, etc. = change in a, b, etc. accompanying a reaction or a group contribution to a, b, etc.

ΔG°_T = standard free energy change at temperature T

ΔH°_{f298} = heat of formation in the ideal gaseous state at 25°C or a group contribution to the heat of formation

ΔH°_T = heat of reaction in the ideal gaseous state at temperature T

S°_{298} = absolute entropy in ideal gaseous state at 25°C and 1.0 atm.

TABLE VI—Literature Comparisons—Heats of Formation ΔH°_{f298} (g)—(kcal/g-mole)

	Experimental	This Work	Deviation	Source
Paraffins				
Butane	−29.7	−29.8	−0.1	(39)
Pentane	−34.7	−35.0	−0.3	(39)
Hexane	−40.0	−40.2	−0.2	(35)
Heptane	−45.4	−45.4	0.0	(35)
Octane	−50.7	−50.6	+0.1	(35)
iso-Butane	−31.4	−31.2	+0.2	(39)
iso-Pentane	−36.7	−36.6	+0.1	(39)
Neopentane	−39.4	−39.3	+0.1	(35)
2—Methylpentane	−41.8	−41.8	0.0	(35)
2,2—Dimethylbutane	−44.4	−44.6	−0.2	(35)
2—Methylhexane	−47.1	−47.0	+0.1	(35)
2,2—Dimethylpentane	−49.8	−49.8	0.0	(35)
2,2,4—Trimethylpentane	−56.2	−56.6	−0.4	(35)
2,2,3,4—Tetramethylbutane	−55.9	−56.0	−0.1	(35)
Hexadecane	−92.1	−92.2	−0.1	(32)
Dotriacontane	−174.6	−175.4	+0.8	(32)
Cycloparaffins				
Methylcyclopentane	−27.0	−26.6	+0.4	(32)
Methylcyclohexane	−36.9	−35.9	+1.0	(32)
Cycloheptane	−40.0	−40.0	0.0	(27)
Methylcycloheptane	−44.5	−45.2	−0.7	(27)
1,2,4—Trimethylcyclopentane	−44.3	−45.9	−1.6	(27)
1—Methyl, 2—Propylcyclopentane	−49.4	−49.5	−0.1	(27)
1,2,3—Trimethylcyclohexane	−55.0	−56.5	−1.5	(27)
Olefins				
Propylene	+5.0	+5.4	+0.4	(39)
Butene—1	+0.4	+0.2	−0.2	(39)
iso-Butene	−3.2	−3.0	+0.2	(39)
cis-Butene—2	−1.4	−1.4	0.0	(39)
trans-Butene—2	−2.3	−2.3	0.0	(39)
Pentene—1	−4.6	−5.0	−0.4	(39)
cis-Pentene—2	−6.4	−6.6	−0.2	(39)
trans-Pentene—2	−7.4	−7.5	−0.1	(39)
2—Methylbutene—1	−8.4	−8.4	0.0	(39)
3—Methylbutene—1	−6.6	−6.6	0.0	(39)
Butadiene—1,3	+26.9	+26.4	−0.5	(39)
Pentadiene—1,3	+18.9	+19.2	+0.3	(39)
2,4,4—Trimethylpentene—1	−27.6	−28.4	+0.8	(39)
Alcohols				
Methanol	−48.3	−52.8	−4.5	(38)
Ethanol	−56.6	−57.3	−0.7	(38)
Propanol	−62.8	−62.5	+0.3	(38)
Butanol	−68.6	−67.7	−0.9	(38)
Pentanol	−74.3	−72.9	+1.4	(38)
Hexanol	−80.0	−78.1	+1.9	(38)
Acids				
Acetic acid	−107.3	−107.1	+0.2	(27)
Propionic acid	−110.0	−111.6	−1.6	(27)
Butyric acid	−114.5	−116.8	−2.3	(27)
Hexyl propiolic acid	−79.0	−77.7	+1.3	(27)
Esters				
Methyl acetate	−99.3	−97.6	+1.7	(27)
Ethyl acetate	−105.4	−104.6	+0.8	(27)
Methyl propionate	−97.4	−102.1	−4.7	(27)
Methyl isobutyrate	−108.5	−108.9	−0.4	(27)
Aldehydes				
Formaldehyde	−28.5	−37.5	—	(27)
Acetaldehyde	−44.7	−44.1	+0.6	(27)
Propionaldehyde	−48.8	−49.5	−0.7	(27)
Ketones				
Acetone	−52.4	−52.5	−0.1	(27)
Methyl ethyl ketone	−57.6	−57.8	−0.2	(27)
Diethyl ketone	−66.8	−63.0	+3.8	(27)
Ethers				
Methyl ethyl ether	−52.8	−53.0	−0.2	(27)
Diethyl ether	−59.7	−60.0	−0.3	(27)
Nitriles				
Acetonitrile	+19.9	+18.9	−1.0	(27)
Propionitrile	+15.4	+14.4	−1.0	(27)
Nitriles (Cont.)				
n-Butyronitrile	+8.3	+9.2	+0.9	(27)
Allylcyanide	+38.3	+39.2	+0.9	(27)
Nitro-compounds				
Nitromethane	−18.8	−18.9	−0.1	(8)
Nitroethane	−23.4	−23.4	0.0	(8)
Fluorine Compounds				
1—Fluoroethanol—2	−96.6	−97.5	−0.9	(9)
1,2—Difluoroacetic Acid	−189.6	−188.2	+1.4	(8)
Bromides				
Methyl bromide	−8.3	−10.1	−1.8	(8)
Ethyl bromide	−15.1	−14.6	+1.5	(8)
1,2—Dibromoethane	−10.2	−9.8	+0.4	(8)
Acetylbromide	−43.0	−42.5	+0.5	(8)
Iodides				
Methyl iodide	+4.7	+4.7	0.0	(8)
Diiodomethane	+25.2	+25.0	−0.2	(8)
Ethyl iodide	−0.8	+0.2	+1.0	(8)
1,2—Diiodoethane	+16.4	+19.8	+3.4	(8)
Acetyliodide	−29.0	−27.7	+1.3	(8)
Propyl iodide	−3.8	−5.0	−1.2	(28)
Iodoform	+44.0	+43.2	−0.8	(8)
Chlorides				
Methyl chloride	−19.9	−20.1	−0.2	(8)
Ethyl chloride	−25.3	−24.6	+0.7	(8)
Allyl chloride	−0.5	+0.2	+0.7	(8)
Propyl chloride	−31.5	−29.8	+1.7	(8)
Chloroform	−23.4	−22.2	+1.2	(8)
Chloroacetic acid	−107.0	−111.6	−4.6	(8)
Chloral	−45.1	−54.2	−9.1	(8)
Vinyl chloride	+9.4	+5.4	−4.0	(8)
1,2—Dichloroethane	−29.7	−29.8	−0.1	(8)
Monochloroethanol	−66.0	−62.5	+3.5	(8)
1,1—Dichloroethane	−28.9	−26.7	+2.2	(8)
Dichloroacetic Acid	−113.6	−113.7	−0.1	(8)
Dichloromethane	−21.5	−20.1	+1.4	(8)
1,2,2,2—Tetrachloroethane	−32.6	−35.6	−3.0	(8)
Phosgene	−53.3	−48.0	+5.3	(8)
Hexachloroethane	−36.6	−38.0	−1.4	(8)
Chloral hydrate	−103.6	−106.7	−3.1	(8)
Trichloroacetylchloride	−64.8	−60.2	+4.6	(8)
Mercaptans				
Methyl mercaptan	−3.4	−4.3	−0.9	(8)
Ethyl mercaptan	−9.6	−8.8	−0.8	(8)
Amides				
Propionamide	−63.5	−63.5	0.0	(27)
Aromatics				
Styrene	+30.9	+32.4	1.5	(27)
Methylstyrene	+25.9	+24.8	−1.1	(27)
Phenyl—1—butene—2	+23.7	+25.1	+1.4	(27)
Aniline	+24.4	+25.9	+1.5	(27)
Diethylaniline	+9.2	+13.2	+4.0	(27)
Benzaldehyde	−10.3	−11.2	−0.9	(27)
Nitrobenzene	+15.9	+14.8	−1.1	(27)
Chlorobenzene	+13.9	+13.6	−0.3	(27)
Phenol	−19.1	−19.1	0.0	(27)
Fluorobenzene	−20.1	−21.4	−1.3	(27)
Propyl cinnamate	−60.2	−64.5	−4.3	(27)
Methyl benzoate	−63.9	−63.9	0.0	(27)
Propyl benzoate	−76.3	−76.1	+0.2	(27)
iso-Butyl benzoate	−85.5	−82.9	+2.6	(27)
Methyl salicylate	−114.1	−117.9	−3.8	(27)
Ethyl salicylate	−126.2	−124.9	+1.3	(27)
Propyl salicylate	−130.7	−130.1	+0.6	(27)
iso-Butyl salicylate	−137.1	−136.9	+0.2	(27)
Dimethyl phthalate	−147.1	−147.7	−0.6	(27)
Thymolmethyl ether	−46.2	−49.3	−3.1	(27)
Thymolethyl ether	−52.8	−56.3	−3.5	(27)
Ethyl phenylpropiolate	−16.7	−17.1	−0.4	(27)
Diphenyl	+43.4	+45.9	+2.5	(27)

$\Delta S°_{298}$ = entropy change in the ideal gaseous state at 25°C and 1.0 atm or a group contribution to the absolute entropy

T = temperature, °K

Literature Cited

(1) Aston, J. G. *Chem. Rev.*, 27, 59-73 (1940).
(2) Aston, J. G. *Ind. Eng. Chem.*, 34, 514-21 (1942).
(3) Aston, J. G., Eidinoff, M. L., and Forster, W. S. *J. Am. Chem. Soc.*, 61, 1539-43 (1939).
(4) Aston, J. G., Fink, H. L., and Schumann, S. C. *J. Am. Chem. Soc.*, 65, 341-46 (1943).
(5) Aston, J. G., Siller, C. W., and Messerly, G. H. *J. Am. Chem. Soc.*, 59, 1743-51 (1937).
(6) Aston, J. G., Szasz, G. J., and Fink, H. L. *J. Am. Chem. Soc.*, 65, 1135-9 (1943).
(7) Bennewitz, K., and Rossner, W. Z. *physik. Chem.*, 39B, 126 (1938).
(8) Bichowsky, F. R., and Rossini, F. D., *"The Thermochemistry of the Chemical Substances"*, Reinhold Publishing Corp., New York, (1936).
(9) Dobratz, C. J. *Ind. Eng. Chem.* 33, 759-62 (1941).
(10) Edgell, W. F., and Glockler, G. *J. Chem. Phys.*, 9, 484-5 (1941).
(11) Egan, C. J., and Kemp, J. D. *J. Am. Chem. Soc.*, 60, 2097-2101 (1938).
(12) Eucken, A., and Sarstedt, B. Z. *physik. Chem.*, B50, 143-70 (1941); *Chem. Zentr.*, 1942, I, 331-2.
(13) Ewell, R. H. *Ind. Eng. Chem.*, 32, 778-83 (1940).
(14) Ewell, R. H., and Bourland, J. F. *J. Chem. Phys.*, 8, 835-6 (1940).
(15) Ewell, R. H., and Hardy, P. E. *J. Am. Chem. Soc.*, 63, 3460-5 (1941).
(16) Fallon, J. F., and Watson, K. M., *National Petroleum News, Technical Section*, 36, R-372-75 (1944).
(17) Fugassi, P., and Rudy, C. E., Jr., *Ind. Eng. Chem.*, 30, 1029-30 (1938).
(18) Gamson, B. W., and Watson, K. M., *National Petroleum News, Technical Section*, 36, R-258-64 (1944).
(19) Guttman, L., Westrum, E. F., Jr., and Pitzer, K. S., *J. Am. Chem. Soc.*, 65, 1246-7 (1943).
(20) Halford, J. O. *J. Chem. Phys.*, 10, 582-4 (1942).
(21) Halford, J. O., and Pecherer, B. *J. Chem. Phys.*, 6, 571-5 (1938).
(22) Hougen, O. A., and Watson, K. M., *"Chemical Process Principles"* (p. 265), John Wiley & Sons, New York, 1943.
(23) *International Critical Tables*, Vols. 3 and 5, 1st ed., McGraw-Hill Book Co., New York, 1929.
(24) Kassel, L. S. *J. Chem. Phys.*, 4, 435-441 (1936).
(25) Kistiakowsky, G. B., and Rice, W. W. *J. Chem. Phys.*, 8, 610-18 (1940).
(26) Kennedy, R. M., Sagenkahn, M., and Aston, J. G. *J. Am. Chem. Soc.*, 63, 2267-72 (1941).
(27) Kharasch, M. S. *Bur. Standards J. Research*, 2, 359-430 (1929).
(28) Kharasch, M. S., and Sher, B. *J. Phys. Chem.*, 29, 625-58 (1925).
(29) Meissner, H. P., and Redding, E. M. *Ind. Eng. Chem.*, 34, 521-6 (1942).
(30) Messerly, G. H., and Aston, J. G. *J. Am. Chem. Soc.*, 62, 886-90 (1940).
(31) Osborne, D. W., Garner, C. S., Doescher, R. N., and Yost, D. M. *J. Am. Chem. Soc.*, 63, 3496-9 (1941).
(32) Parks, G. S. *Chem. Rev.*, 27, 75-83 (1940).
(33) Pauling, L., "The Nature of the Chemical Bond and the Structure of Molecules and Crystals," 2nd ed., Cornell Univ. Press, Ithaca, N. Y., 1940.
(34) Pitzer, K. S. *J. Am. Chem. Soc.*, 62, 331-5 (1940).
(35) Pitzer, K. S. *Chem. Rev.*, 27, 39-57 (1940).
(36) Pitzer, K. S., and Scott, D. W. *J. Am. Chem. Soc.*, 63, 2419-22 (1941).
(37) Pitzer, K. S., and Scott, D. W. *J. Am. Chem. Soc.* 65, 803-29 (1943).
(38) Rossini, F. D. *Bur. Standards J. Research*, 13, 21 and 189 (1934).
(39) Rossini, F. D. *Chem. Rev.* 27, 1-16 (1940).
(40) Rossini, F. D., Prosen, E. J. R., and Pitzer, K. S. *J. Research Natl. Bur. Standards*, 27, 529-41 (1941).
(41) Russell, H., Jr., Osborne, D. W., and Yost, D. M. *J. Am. Chem. Soc.*, 64, 165-9 (1942).
(42) Schumann, S. C., and Aston, J. G. *J. Chem. Phys.*, 6, 485-8 (1938).
(43) Spencer, H. M., and Flannagan, G. N. *J. Am. Chem. Soc.*, 64, 2511-3 (1942).
(44) Stevenson, D. P., and Beach, J. Y. *J. Chem. Phys.*, 6, 25-9 and 108 (1938).
(45) Stull, D. W., *Ind. Eng. Chem.*, 35, 1303-4 (1943).
(46) Stull, D. R., and Mayfield, F. D. *Ind. Eng. Chem.*, 35, 639-45 (1943).
(47) Watson, K. M. *Ind. Eng. Chem.*, 35, 398-406 (1943).
(48) Wenner, R. R., *"Thermochemical Calculations"*, 1st ed., McGraw-Hill Book Co., New York, 1941.
(49) Yost, D. M., Osborne, D. W., and Garner, C. S. *J. Am. Chem. Soc.*, 63, 3492-6 (1941).

TABLE VII—Literature Comparisons—Absolute Entropies $S°_{298}$ (g)—(cal)/(g-mole) (°K)

	Literature	This Work	Deviation	Source
n-Butane	74.2	73.9	—0.3	(35)
n-Pentane	83.2	83.1	—0.1	(35)
n-Hexane	92.4	92.3	—0.1	(35)
n-Heptane	101.6	101.5	—0.1	(35)
n-Octane	110.7	110.7	0.0	(35)
iso-Butane	70.5	70.5	0.0	(35)
iso-Pentane	82.0	80.9	1.1	(35)
2—Methylpentane	90.1	90.1	0.0	(35)
2,3—Dimethylbutane	86.5	87.2	+0.7	(35)
3—Methylpentane	90.0	90.1	+0.1	(35)
2—Methylhexane	99.5	99.3	—0.2	(35)
Hexadecane	184.3	184.3	0.0	(32)*
2,3,4—Trimethylpentane	101.4	101.9	+0.5	(35)
Ethylene	52.7	52.8	+0.1	(35)
Propylene	65.1	65.5	+0.4	(35)
iso-Butene	71.3	72.7	+1.4	(35)
2—Methylbutene—1	83.4	83.1	—0.3	(15)
2—Methylbutene—2	82.8	82.5	—0.3	(15)
3—Methylbutene—1	82.0	81.7	—0.3	(15)
Methylcyclopentane	82.2	82.2	0.0	(32)*
Ethylcyclopentane	91.3	91.7	+0.4	(32)*
Methylcyclohexane	83.8	82.9	—0.9	(32)*
Chloromethane	55.9	55.9	0.0	(30)
Dichloromethane	64.7	64.7	0.0	(44)
1,2—Dichloroethane	73.7	73.9	+0.2	(34)*
Chloroform	70.8	70.5	—0.3	(44)
Carbon tetrachloride	74.2	73.2	—1.0	(44)
Bromomethane	58.7	58.9	+0.2	(11)
Dibromomethane	70.2	70.7	+0.5	(10)
1,2—Dibromoethane	78.7	79.9	+1.2	(34)*
Bromoform	79.1	79.5	+0.4	(44)
Carbon tetrabromide	85.6	85.2	—0.4	(44)
Methyl iodide	60.8	60.9	+0.1	(10)
Methyl fluoride	53.3	54.9	+1.6	(10)
Fluorotrichloromethane	74.1	72.2	—1.9	(31)
Methanol	57.7	57.5	—0.2	(21)
Ethanol	66.4	67.3	+0.9	(2)
Isopropanol	73.4	73.1	—0.3	(42)*
Phosgene	67.2	72.7	5.5	(44)
Styrene	82.1	81.2	0.9	(19)
Nitrobenzene	78.4	78.4	0.0	(48)*
Aniline	71.6	71.6	0.0	(48)*
n-Butylbenzene	102.0	104.8	2.8	(48)*
tert-Butylbenzene	90.4	90.4	0.0	(48)*

*Value listed under "literature" was obtained by converting standard liquid entropy to the ideal gaseous state by generalized relations.

TABLE VIII—Literature Comparisons—Heat Capacities and Enthalpies

A. Data from Bennewitz and Rossner[7] (experimental)

		$c°_p$			
	T°K	Literature	This Work	Difference	% Deviation
Benzene	410	27.1	27.6	+0.5	+1.8
Toluene	410	33.2	34.2	+1.0	+3.0
Cyclohexane	410	37.0	38.3	+1.3	+3.5
Methylcyclohexane	410	44.1	44.8	+0.7	+1.6
Acetone	410	22.3	22.4	+0.1	+0.4
Methylethyl ketone	410	29.6	30.4	+0.8	+2.7
Ethyl alcohol	410	19.6	21.2	+1.6	+8.2
Methyl acetate	410	27.3	26.3	—1.0	—3.7
Ethyl formate	410	27.7	26.4	—1.3	—4.7
Ethyl acetate	410	33.4	32.6	—0.8	—2.4
Ethyl propionate	410	39.1	39.5	+0.4	+1.0

B. Data from Eucken and Sarstedt[12] (experimental)

Hexane	451	48.9	49.1	+0.2	+0.4
	574	57.6	58.5	+0.9	+1.6
Neohexane	451	48.5	51.1	+2.6	+5.4
Heptane	450	57.3	57.5	+0.2	+0.3

C. Data from Pitzer[35] (calculated)

		$H_T - H_{298.1}$ (cal/g-mole)			
	T°K	Literature	This Work	Difference	% Deviation
2,2,4—Trimethylpentane	600	17,610	17,808	+208	+1.2
	1000	51,500	52,127	+627	+1.2
	1500	101,710	102,012	+302	+0.3
2,2,3,3—Trimethylbutane	600	20,250	20,500	+250	+1.2
	1000	59,250	59,093	—157	—0.3
	1500	116,790	116,540	—250	—0.2
Pentane	600	12,360	12 281	— 79	—0.6
	1000	36,400	36,377	— 23	—0.1
	1500	72,740	72,495	—245	—0.3
Octane	600	19,530	19,500	—30	—0.2
	1000	56,180	57,188	+1008	+1.8
	1500	113,690	113,434	—256	—0.2

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WIDENING HORIZONS

Views on Personnel, Management and Economic as Well as Technological Developments in Petroleum Refining and Natural Gas Processing: Comment from Readers Is Invited

Biddle Espouses the New Deal Program For Socializing Inventors' Rights

THE NEW DEAL still holds to its program for socializing inventors' rights, the exact opposite of the principle of the American patent system.

A letter from Attorney General Biddle, energetic exponent of wider government powers over business on all horizons, to Senator Gillette of Iowa gives the former's ideas on ownership and licensing of patents. The letter discusses the agreements between the oil companies and other parties and the Rubber Reserve Co. for the pooling of patents and technical information to provide means for the large volume manufacture of synthetic rubber in the war emergency.

Mr. Biddle's letter was in reply to an inquiry from the senator, who is chairman of a special Senate committee which has been investigating the use of farm and forestry products in making synthetic rubber. Senator Gillette had asked, among other points, whether the agreements had the approval of the Department of Justice.

After discussing at some length earlier statements from the Attorney General's Office to the effect that agreements made under the Emergency Act and faithfully carried out would not constitute a violation of the anti-trust laws, Mr. Biddle says:

"It is the view of this department that the agreements under consideration do tend to create a monopoly in the synthetic rubber industry to the extent that they provide for patent pooling between various companies and do not require licensing to future applicants. . . . . The Department has felt that some protection was afforded the public by the power given Defense Plant Corp. or the Federal Loan Administrator to direct that licenses be given to new applicants. This power, however, is not unqualified and after the war a refusal on the part of the participants in the patent pools to license new applicants may constitute a violation of the anti-trust laws. . . . . Your committee may wish to consider, however, whether it might not be wise to insure the continuance of the licensing of these patents."

This statement seems typical of the muddy thinking of the Department of Justice in matters relating to patent ownership and of the consistent espousal of principles inimical to our existing patent systems.

The Department of Justice always seems to think that what it is pleased to call a "pooling" of patents, which is really a broad cross-licensing arrangement, tends to promote monopoly, while actually the opposite is true. Any patent starts out by being a monopoly but the more widely it is cross-licensed or "pooled" the more competition comes into the picture, as has been demonstrated in all industry's history, and the less monopoly is involved.

In the case of the synthetic rubber patents, it was vital that all operators be licensed to use all new developments as promptly as possible and a general cross-licensing arrangement or pooling was the only possible answer. On the other hand, it is difficult to see why there should be compulsion on any company or individual inventor to license future patents that may come along after the end of the war. If we want to preserve the prime stimulus to research and development, the value of which has been so many times demonstrated in this wartime period, the companies which have waived their individual rights in the emergency should have the right to benefit from future improvements in processes and from the licensing of inventions.

While the agreements between the Rubber Reserve Co. and private concerns do not "require," they provide for licensing of new operators upon mutually acceptable terms and conditions not less favorable than those with other operators, during the life of the patents in at least some cases. The courts, as in the past, constitute a means for recourse for individual parties or the government in case of the unjustified withholding of licenses.

The New Deal's theory on inventors' rights also apparently differs widely with the present system on the ownership of inventions of employes. Attorney General Biddle suggests in his letter to Senator Gillette that his committee "may wish to consider a policy for the disposition of inventions developed in the operations of plants created at government expense."

Under the American patent system the rights of both employer and employe are equitably protected by court law. The principle has been upheld many times that where a man was hired to work on a definite project to the end of developing a new method or process, the rights to inventions in connection with that work belonged to the employer. Where the invention is incidental to the work for which the man was hired, ownership rests with the individual, with the employer insured the privilege of licensing.

In the case of direct government-operated plants or direct research projects, the government stands in the same position as any employer and its rights are now protected. Inventors' rights are also protected. In the case of inventions by employes in plants which, while financed by the government, are operated by oil or other private companies it would seem to be far fetched to claim the government had an interest in or control of inventions made by workers there.

To set up a right of the government to own or control the disposition of inventions made in government financed but privately operated war plants would be an opening door to socializing the rights of all inventors and would mean a revolutionary change in the American patent system.

Second Anniversary Issue

This issue of the Technical Section marks the second anniversary of the inauguration by NATIONAL PETROLEUM NEWS of a journal which provides within one cover once a month carefully selected technical papers and original articles of timely interest to refining technologists and plant operators.

This occasion provides an opportunity for its staff to express sincere appreciation to the many contributors and others who have given the benefit of their knowledge and experience to aid in charting its editorial program. By now some of the buoys have been set out which mark the channels where reader interest and attention flow with the deepest currents. Along this course of selected subjects we plan to move in coming months with even greater progress than in the first two years.

Technical Section, NATIONAL PETROLEUM NEWS

Published Every Month by

The National Petroleum Publishing Company

Publication Office, 1213 West Third Street, Cleveland 13, Ohio, U. S. A.

V. B. Guthrie, Editor, Technical Section • D. P. Thornton, Jr., Assistant Editor

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